ENGINEERING NEWS

The *Electric Age*, in its last issue summarizes progress in electric railways by showing that there are already 130 miles of road in operation on this continent. Of this number, 21 miles are in Pennsylvania, 16 in New York, 10 in Ohio, and 83 in New Jersey, Maryland, Colorado, Michigan, Missouri, California, Alabama, Virginia, Kansas, Delaware, Rhode Island and Ontario combined. Almost all of this building has been done in the past year. There are in course of construction, or contracted for, 150 additional miles in the States of New York, Massachusetts, Connecticut, Tennessee, Ohio, California, Pennsylvania, Nebraska, Kentucky, and Minnesota. On these various roads, constructed and constructing, in 62 different towns and cities, the Van Depoele system is used, or to be used, in 17 cases, the Daft system in 15 cases, the Sprague system in 7 cases, and the Bentley-Knight, the Heart, the Henry, the Julien, and other systems in the remaining cases. The last named system is announced as likely to be used on Fourth Avenue, New York, which we shall believe when we see it, while the Daft system is in use at Los Angeles, where the first electrical railroad was opened for business in the winter of 1886-7.

In the article on the Finley-Helio-Telegraph in ENGINEERING NEWS of April 28, the name of the company manufacturing the apparatus was incorrectly given as the "American Heliograph and Signal Company". It should have been the "American Helio-Telegraph and Signal Light Company, No. 1304 L Street, Washington, D. C". Mr. JAS. C. TRUMAN is the President of the company.

THE news from Nicaragua is, that the canal survey is progressing satisfactorily, and that the members of the expedition are in good health. The following work had been completed April 14.

The survey of the San Juanillo river and Silico Lagoon, with soundings and gauging; the gauging and cross sectioning of all the streams crossing the line from Ochoa to Greytown; the borings along the line and at the sites of the dam, embankments, locks, culverts, etc., from Ochoa to San Juanillo; the survey of the upper river from Fort San Carlos to and including Toro rapids; the location of the lower route from the dam at Ochoa to the San Juanillo river, except a gap of less than two miles; and the preliminary line between San Juanillo and Greytown, except about three miles.

Mr. JACOBSON, an engineer just returned from the Panama Canal, after 18 months of work thereon, who is now in New York, says that work has been commenced on the Gamboa dam, which has finally been decided necessary for controlling the Chagres river. About 30,000 cu. yds, of material, or one per cent. of the total amount it will require, have been deposited at opposite ends of the work, on the sides of the two large hills between which the dam is situated. These deposits are out of the way of the current, even during a freshet; but when the middle of the dam is built unless it can be completed in a single dry season, it will be almost impossible to keep the material from washing away. During the rainy season which has now set in, little can be done. Some work has been done in M. EIFFEL'S behalf on the excavation for the new locks, but not much.

Mr. EDISON'S new phonograph, just perfected, consists of a small screw 4 ins. long with 100 threads to the inch which feeds the frame carrying receiver and transmitter. The receiver is a delicate metal needle which operates on a phonograph blank of white wax placed on a metal drum. There is a recorder consisting of a steel knife fastened to a diaphragm. On a single blank 1,000 to 1,200 words can be recorded, and each blank can be automatically pared for new records from 15 to 20 times.

The motor is in a box 11 ins. square, to which the phonograph is connected by two screws. The armature is a horizontal ring of metal with 10 pole pieces placed on the rim at regular intervals.

This machine reproduces sounds so that the voices of the speakers are clearly recognized. The inventor expects to have it on the market within a month.

THE bill to abolish the present Board of Trustees of the Brooklyn Bridge and to substitute therefor a new Board of only 3 trustees instead of 20 passed both houses of the New York Legislature before its adjournment by an almost unanimous vote, there being only three or four negative votes in each house, and is now in the hands of the Governor, who seems to be expected either to sign it within the 30 days allowed by law or permit the bill to become a law without his signature. The Mayors of New York and Brooklyn then have 30 days to appoint the new Trustees, when the terms of office of the present Board expire by limitation. What is expected to be the last meeting of the present Board was held on Monday, 14th inst., 13 trustees in all being present, including Messrs. HOWELL and CLARKE, of the late Terminal Committee.

At this meeting Trustee CHAS. S. HIGGINS called for the reading of the letter by Mr. A. M. WELLINGTON (ENG. NEWS, April 17) claiming exaggerations aggregating nearly $4,000,000 in certain specified items of the estimate which was put forward as the ground for rejecting the recommendations of their Board of Experts by the Terminal Committee, and stating that it was due to both Messrs. MARTIN and WELLINGTON that the facts should be investigated, moved reconsideration. Mr. BUSH moved to lay the motion on the table. Trustee THOS. C. CLARKE followed in a statement reprinted in full elsewhere, opposing any reconsideration. Mr. BUSH'S motion was then carried by 12 to 1 without further discussion.

THE most serious railway accident of the week was a rear collision on the Erie road near the west end of Bergen tunnel, near Jersey City. A train was waiting for the signal to enter the tunnel when it was run into by an express. The standing train was protected by the signals, but the driver of the express claimed that the brakes would not act and that the rails were slippery from the rain. About 17 persons were injured, some seriously.——At Fountain, Col., on the Atchison, Topeka & Santa Fé R. R., some sidetracked freight cars got loose May 14 and ran into a passenger train; a car of giant powder exploded and much damage was done. Three persons were killed and a number injured, some fatally.——A passenger train on the Southern Pacific was derailed May 12, on a trestle near Gila Bend, Ariz. One person was killed.

SERIOUS damage has been done by the high water in the Mississippi. The levees have given way in several places and large tracts of country are inundated. About 500 ft. of a dam at Rock Island, Ill., were carried away May 11. This dam was built in 1874 at a cost of more than $100,000. It was composed of solid blocks of Nauvoo stone, 23 ft. high and 12 ft. thick. It was sustained on the lower side by buttresses at intervals of 50 ft. The difference in the water level above and below the dam was 7 ft.——The damage by floods continues in the Northwest and the South.——Washouts have occurred on the Bennington & Rutland and South Carolina railways.——A train was derailed on the former, near Danby.

THE temporary bridge used in the construction of the new iron bridge over the Thames river near Glencoe, Ont., gave way May 10, precipitating 6 men into the water. Two men were killed, and the others seriously injured.

EXTENSIVE terminal improvements are proposed for Sandusky, which if carried out will add greatly to its importance as a trans-shipping point. The terminal facilities of the Sandusky, Ashland & Coshocton Railway are to consist of a pier 1,650 ft. long for grain and miscellaneous freight, two piers, 2,000 ft. and 2,500 ft. long for ore, a pier 2,250 ft. long for lumber, a pier 2,800 ft. long for coal, and a bulkhead 1,820 × 1,000 ft., on which the trains for the various piers will be made up and assorted. The entire system of tracks aggregates 20 miles in length. The Sandusky Ship-Yard, Dry-Dock & Engine Co. will have a wharf 500 × 500 ft.

THE Detroit "winter bridge" project is again being actively pushed. The bill now before Congress, provides that the bridge when built shall be open to all roads for reasonable compensation, that plans are to be approved by the Secretary of War, and the adminstration of the bridge shall be under his supervision, and furthermore:

Shall have at least two pivot or other draws, one with arms of at least 400 ft. in length on each side of the center pier, the other with two openings of 200 ft. each in the clear. These draws shall be so placed as to best accommodate the navigation of said river, and said bridge shall not be less than 15 ft. high above high-water mark, measuring to the bottom chord of the bridge; and the said draws, *during the season of navigation shall at all times remain open*, and during the remainder of the year said draws shall, for the accommodation of river traffic, be promptly opened at all times upon the customary signals being given.

IT is stated that Ohio petroleum has been successfully used as a fuel in many large establishments in and near Chicago, but that the insurance companies are opposing its introduction. The Ohio fields are at present producing about 25,000 barrels per day, and the amount at present stored in tanks is more than 6,000,000 barrels.

The Union Steel Works of Chicago are now using 1000 barrels of oil per day in place of 400 tons of coal formerly used. The change in fuel dispenses with 65 laborers. The relative cost of coal and oil is not given in this case, but at the Leland house it is said that 18 barrels of oil were used per day in place of coal with a daily saving of $5. In the burning of brick and lime, oil can be used to great advantage and is being generally adopted.

AN old Pennsylvania Railroad locomotive has been remodeled and fitted with a device for burning gas made from petroleum. There is a sheet-iron storage tank with a capacity of 4½ barrels on the rear of the tender, and the oil passes from this into a rectangular retort with a fire-box under it. A small vertical boiler with 13 tubes is in connection with the fire-box of the retort, and completes the arrangement for manufacturing the gas. The gas and also two steam jets are introduced into the locomotive fire-box. The first trial of the apparatus showed that some modification of details was required, but that it was possible to get up steam in much less time than with coal, and that the steam pressure could be easily maintained by the gas.

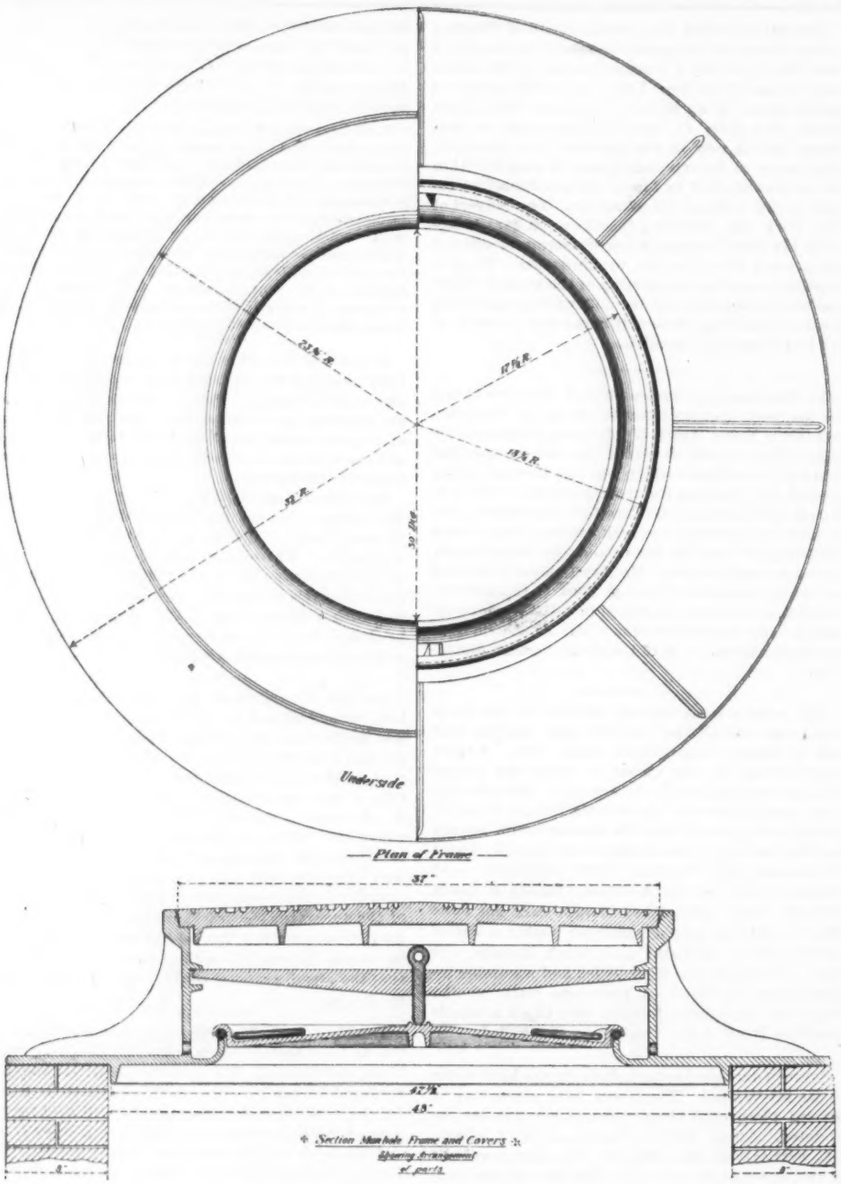
THE New York, New Haven & Hartford Railroad Co. is introducing scoop troughs between New York and Boston. Six new Baldwin locomotives arranged for taking water in this way will be ready for the road May 1. The troughs will be 1,500 ft. long. A water privilege has already been purchased, and the work will be completed this summer. The Central Railroad of New Jersey is also introducing the system. It seems a little surprising that such prominent roads have not introduced this time saving device before, as they certainly have good use for it.

THERE is some delay in acting on the plans for improved railway terminal facilities at Providence, R. I., occasioned apparently by adverse criticism on the manifestly unfortunate feature of removing the depot half a mile further from the center of the city. The Mayor advised the Aldermen to appoint a committee of six to confer with all the railroads interested and get opinions on the experts' report, and this committee was chosen April 30.

IN the attempt to drive the first pile for the new bridge at New London, Ct., elsewhere described, the bridge builders could not get a pile long enough to reach through the water and mud. Two piles were spliced together, making a total length of 112 ft., and this was driven to within a foot of the surface of the water without getting it through the dam. It is thought that the length necessary will be 130 ft.

AT Galveston, Tex., the water from a new artesian well, which is 856 ft. deep and discharges 150,000 galls. daily, was found to be heavily charged with gas, the quantity being thought sufficient to run the machinery connected with the works.

IT is said that there is a good prospect of the City Council of Chicago reporting favorably on the Meigs elevated railway system for that city.



Figs. 1 and 2.—Plan and Section.

Fig. 4.—Plan of Street Cover.

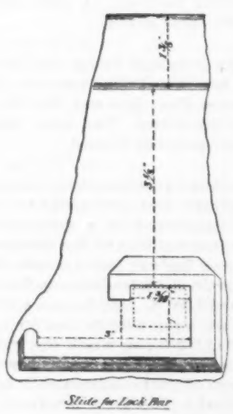


Fig. 5.—Slide for Lo

STANDARD MANHOLE COVER. NEW YORK ELECTRICAL SUBWAYS.

Electrical Subways of New York.

(Continued from page 359.)

MANHOLES.

In general, the conduits consist of one or more tubes or ducts laid in a trench, in lengths of a block, or of about 260 ft., the lengths terminating in manholes by means of which access can be had to the ducts without disturbing the pavements. The tubes are made as nearly gas and water-tight as may be, and with a smooth and continuous surface on the inside so that the wire cables can be readily drawn through them. As a general rule the manholes are placed at the intersections of the streets, but in the case of long blocks they are put in more frequently so as not to exceed the limit of about 260 ft., which corresponds with the length of cable which it is convenient to handle.

Fig. 3.—Plan of Inner Cover.

As the construction of the cables and the operation f handling them will not allow any sharp curves or angles in a single length of duct, manholes must be placed at every point when a considerable change of alignment or grade is required. Before placing a length of conduit it is necessary to excavate the trench for its full length so as to determine from the location of pipes and other obstructions, at what grade the conduit can be laid. The general elevation of the next length may be higher or lower, and it may be placed to one side or the other of the line of the first mentioned length; the alteration in direction can only be made in the flexible cable, at the manholes. These changes frequently lead to wide variations from the ideal plan of manhole.

The manholes are of brick laid in hydraulic cement mortar, with a cement mortar flooring. The cover is designed to be water-tight, but is always gradually loosened by the passage of teams. Figures 1—5, show the cover which has been adopted as the standard for all manholes now building, or hereafter to be built. Whatever may be the dimension of the manhole, the top of it is reduced to the proper size by bridges of blue stone or granite or by brick arches sprung from iron girders.

An instance of the successful transmission of power by electricity over long distances is found, according to the London *Electrician*, at the Phœnix Gold Mines in New Zealand, where Pelton waterwheels, with a head of 180 ft. drive two Brush machines. The current is conveyed to a Victoria motor 3 miles distant, by a copper wire 0.165 ins. in diameter, supported on telegraph poles, 6 miles of this wire being used in the complete circuit. About 50 H. P. is developed, and it is said that only 3 H. P. is lost on the line.

THE proposition to let a railroad survey in Colorado to the lowest bidder calls forth an earnest protest from engineers in that State. They say that no engineer can make a close estimate of the cost of locating the best line until the work has been done, and that contract surveys can only result in poorly located lines. If such a method should become general, real estate agents and lawyers would soon be locating railroads by contract, just as it is said they are now doing land surveying for the Government.

Good and Bad Car Wheels.

The report of the Mass. R. R. Commission on the Bradford accident of Jan. 10 last, on the Boston & Maine Railroad, contains as much and as good information on the subject of good and bad car wheel practice as has anywhere appeared in the same space. Therefore, we reprint it almost in full. We wish we could endorse the report with equal emphasis for what it says on the lesson of that disaster as to bridge guards, but while there is little reason to object to that report for what it does say, there is considerable reason to regret that it does not say more, for the accident was as good evidence of the probable efficiency of re-railing guards as has ever occurred, apart from the numerous ones where they have been in place and have done their work.

After pointing out that the system of wheel inspection on the Boston & Maine was very loose, and that the tendency in New England is to use steel tired wheels for passenger stock, the report gives the following interesting correspondence:

From Theo. N. Ely, General Superintendent of Motive Power of the Pennsylvania Railroad Company, dated Feb. 3, 1888.

The Pennsylvania Railroad uses for its standard practice under both freight and passenger cars cast-iron wheels. The wheels used are made at the company's foundry at Altoona, which turns out, on an average, about 100,000 wheels each year. Owing to the large increase in the equipment, this number does not fully meet the demands of the service, and we are consequently obliged to purchase the wheels of other makers. Appreciating the fact that the market has from time to time been flooded with wheels which are not safe, we prepared the specifications enclosed, and since that date have purchased no wheels which did not meet these requirements, and have thus far been able to secure all the wheels we desire, made in accordance therewith. We have been gratified to learn that the issuing of these specifications has been followed by demands from other railroads upon the manufacturers for wheels to be made under similar specifications. The tests required are not excessive and are perfectly practicable, as the wheels can readily be made by any honestly disposed wheel manufacturer.

The Pennsylvania Railroad has in service under passenger equipment about 24,000 cast-iron wheels made at Altoona: the broken and cracked wheels in 1887 were about .004 per cent. Our inspection is very rigid, and we do not allow any wheels to run in which any symptom of weakness is discovered. It is therefore probable that some of the wheels which were removed could have run safely a very much longer time, were we willing to take any chances. There are in the freight service about 350,000 Altoona cast iron wheels, made of the same material as is used in the passenger wheels, the number of which removed in 1887, cracked or broken from all causes, was .0014 per cent. We endeavor to make our inspection of freight wheels as rigid as that of passenger, the importance of which cannot be over-estimated; especially on double-track railroads where trains pass each other at speed. In addition to these 350,000 wheels there are other purchased cast-iron wheels in service, but as they are a small proportion of the whole number the percentage of broken wheels would not be comparative.

Before leaving the subject of cast-iron wheels, there is a natural tendency of wheel makers, who sell their product under guarantees for a certain number of years, or given number of miles, to make the wheels as durable as possible, and this is often done at the expense of the strength of the wheel, as toughness and durability do not always go together. The policy of the Pennsylvania Railroad has been, first, to secure as far as possible perfectly safe wheels, and next, to make them as durable as possible; this, we think, is the principle which should govern in all cases.

The experience of this company for a number of years, as evidenced by carefully kept records, shows that cast-iron wheels can be made perfectly safe for passenger and freight service, and on the ground of safety we would not think of abandoning their use for wheels made from any other material that we know of, including the various styles of steel-tired wheels. As regards steel-tired wheels the Pennsylvania Railroad has comparatively few in service, probably not more than 2,500 or 3,000, and, owing to the numerous parts of which many of them are composed, the percentage of failures is larger than in the case of cast-iron wheels. As there is a limit to the diameter to which cast-iron wheels can be made to advantage, steel-tired wheels will necessarily come more or less into use; and, as a matter of fact, even smaller diameters of steel-tired wheels are preferred by some railroads. Our records of the different styles of wheels go to show that the best, safest and cheapest wheel is one having a center of either spokes or discs of wrought-iron, with the tire fastened by the "Mansell" or "Gibson" retaining rings. Such wheels can be made by any manufacturer, entirely free from patents.

PENNSYLVANIA SPECIFICATIONS FOR THIRTY-THREE-INCH CAST IRON CAR WHEELS.

Design.—The design of wheels must be such that they will be in accordance with the measurements shown in the drawing accompanying these specifications, and also such that the wheels made from them shall weigh between 525 and 575 lbs. each.

Inspection.—Wheels must all be cast in true metallic chills of the same internal diameter and uniform cross-section. The treads must be smooth and practically free from "sweat", and must have clear white iron extending to a depth of not less than ¼-in. at the throat, and with a variation of not more than ¾-in. throughout the same wheel. Each wheel must be so nearly cylindrical that when a true metallic ring is placed upon the tread and bears somewhere on the cone, it shall at no part of the circumference stand more than ⅛-in. from the wheel tread. No wheel will be accepted whose circumference differs by more than 1½ ins. or less than 1-in. from the circumference of the chill in which it is made.

The body of the wheel must be composed of soft grey iron, with uniform fracture and free from defects; each wheel must be capable of withstanding a pressure of 45 tons in mounting on axle.

Test.—Representative wheels taken at random by this company's inspector will be subjected to a strength test, under a falling weight, in a machine like that shown on drawing accompanying these specifications, with an anvil block weighing 1700 lbs. set on rubble masonry 2 ft. deep. Manufacturers furnishing wheels to this company will be required to provide one of these machines, and furnish wheels for test, as well as such facilities to the company's inspector as will enable him to test and inspect wheels promptly; they will also be required to give notice to the superintendent of motive power when wheels are ready for inspection and test. The wheels tested will be placed flange downward and rest upon the 3 supports on the anvil block, and be struck centrally upon the hub with the weight of 140 lbs. falling 12 ft.

For each 100 wheels which pass inspection at foundry and are ready for shipment, one representative wheel shall be selected and tested as above described. Should this wheel stand 5 blows without breaking in two or more pieces the 100 wheels may be shipped; but should this wheel break in pieces with 5 blows or less, 2 more wheels representing the same 100 wheels shall be taken and tested, and if any 2 of the 3 wheels tested should break in pieces with less than 3 blows, or if the average number of blows required to break the 3 wheels in pieces is less than 4, the 100 wheels will be rejected. Otherwise they may be shipped, but the shipment in any case will be made subject to the return of such as are found, upon boring and mounting, not to conform otherwise to these specifications. Each wheel must bear a serial number, with name of maker and date of casting.

From J. M. Barr, Superintendent Motive Power of the Chicago, Milwaukee & St. Paul Railway. Dated March 15.

My experience is that steel-tired wheels are more liable to break than good cast-iron wheels. Every year a steel-tired wheel runs increases its liability to breakage, and the evidence furnished by those in use is that they are no safer than cast iron wheels. In ordinary cast-iron wheels made to meet the demands of the market, it requires from 3 to 130 blows from a 100-lb. drop-hammer falling 7 ft. to break a piece out of the outside single plate. Our own wheels stand an average of 50 blows.

There is less variation in steel-tired wheels than in cast-iron wheels, as manufacturers have tried to keep up the quality, but there is reason to believe that as competition becomes closer they will deteriorate as cast-iron wheels have done. We have had a number of steel-tires split, and I believe the reason is that rolling the tire and forming the flange and inside projections causes a lack of uniformity in the metal. A cast-iron wheel being in one piece, there is no danger of parts coming loose; in good wheels the tread is hard and unyielding and presents the most desirable kind of surface to the rail. I am of the opinion that specifications could be drawn up for cast-iron wheels which would ensure a far safer wheel than any steel-tired wheel yet made. Such preliminary specifications have been prepared by a committee of the Wheel Makers', the Master Car Builders' and the Master Mechanics' associations. They would exclude nine-tenths of the wheels made in this country, but could be lived up to.

From Herbert Wallis, Mechanical Superintendent of the Grand Trunk Railway of Canada. Dated Feb. 24.

The number of wheels in service on my division is 109,564, of which 4,604 are under passenger, and 104,660 are under freight cars.

Cast-iron wheels are used under the freight cars. The standard passenger wheel has a wrought iron or cast-steel center, either a disc or spokes, giving with a new 3-in. tire an out-side diameter of 43 ins. Of these wheels 3,188 are in service, or about 70 per cent. of all under passenger cars, the remainder being cast-iron.

I began in 1875, using a spoke wheel built up in sections welded by hydraulic pressure, with steel tire. The tires, after being shrunk on are secured against getting away in case of breakage by the Mansell retaining ring.

I enclose a statement showing the mileage service of tires from these wheels, including a summary of those which have been worn out to date, from which you will see that the average mileage per tire has been something over 162,000, with a maximum of over half a million, and a minimum of 6,000. An examination of the statement shows that the quality of the tires recently received has not been as satisfactory as that of those which were put in during the early part of our experience, and that therefore the average mileage (by no means an unsatisfactory one, however) could be increased by an improvement in the quality of the steel.

In two cases only have accidents happened through failure of the wrought-iron wheel, and in neither case, I am glad to say, was the result serious. It is, however, the failure in these two cases which prompted me to consider the use of disc centers.

The test we apply to cast-iron wheels before putting them into service, is striking them on the hub with four swinging blows with a 40-lb. hammer. This test, I am aware, is not by any means a severe one, but it is used merely to find out flaws or incipient cracks which would possibly result from unequal contraction and want of proper annealing. We have sufficient evidence to show that it answers its purpose, though it does not prevent the wheel breakage which seems unavoidable at times, particularly in the winter, with cast iron wheels. In regard to the breakage of cast-iron wheels, I find that there have been discarded for breakages or cracks, during the past year, 154 wheels from passenger and 2,179 from freight cars, being at the rate of 8 per cent. in the former and 20 per cent. in the latter, per annum. To these breakages the first 4 months of the year contributed 82 per cent. in passenger and 41 per cent. in freight service, showing the destructive influence of a rigid road-bed.

From the Chicago, Burlington and Quincy Railroad Company, Henry B. Stone, General Manager, G. W. Rhodes, Superintendent Motive Power. Dated Feb 3.

Under passenger equipment, we have mostly 33 ins., Bouton cast-iron wheels. Of the steel-tired wheels the largest number are paper wheels. Our freight equipment is fitted exclusively with cast iron wheels. Our material specification for wheels of all classes is as follows—one-third Salisbury iron, one-third Hanging Rock and Southern Pig irons, one-third old wheels.

Under passenger cars we find no cast-iron wheels removed during 1887 on account of being broken. There were a few cases of cracked flange and rim of wheel cracked, but no more so than we have had with steel-tired wheels. One 42-in. steel-tired wheel under a mail car split through the center in service, and one 42-in. paper wheel under a Pullman car broke through the tire, letting a large piece out which derailed the train. In the latter case the tire was worn too thin, having reached ⅞ in. thickness. Under our fast passenger service cars we are now advocating the use of a 42-in. wheel, and inasmuch as this size of wheel when made of cast-iron is so exceedingly heavy and also difficult to manufacture, we are now advocating the use of a lighter steel-tired wheel. For all other services we are using cast-iron wheels.

From George M. Pullman, President Pullman Palace Car Company, dated January 27.

For 12 years this company have been using the Allen paper steel-tired car wheels, and now have over 11,000 in service. More than 3,000 of these wheels have been re-tired after an average mileage of 340,843 miles per tire. Some centers have been re-tired twice and some three times.

Very few tires have broken in service, and not a single passenger has been injured by such breakage.

From George Hackney, Superintendent of Machinery, Atchison, Topeka & Santa Fé Railroad, dated February 13.

The tire of a paper car wheel when new is 2¼ ins. thick, and its average life is 3 years and 9 months. The average miles run for ⅛-in. wear is 14,000. We have kept tires in service, in the past, until reduced to ¾-in. in thickness, making the average mileage 280,000 miles, but we now discard them when reduced to less than 1 in. in thickness.

Cast-iron wheels are guaranteed to us for 3 years freight service, and our records show that their average life is 5 years and 3 months, the total run being estimated at 57,000 to 60,000 miles.

From Mr. J. F. Goddard, General Manager:

We use the Allen paper wheel. The tires cost about $53 per wheel, and are guaranteed to run 200,000 miles. The average run per ⅛-in. wear was, in 1887, 13,947 miles.

Our records show the following failures of paper wheels during the year 1887, out of 3,754 wheels: 3 broken hubs, 1 broken plate, 1 tire split, 2 tires broken and bolts in plates broken in 1 wheel.

The above are the only serious defects discovered by our mechanical department during the year.

While the foregoing authorities differ on the question whether a steel-tired or a cast-iron wheel is the better, they all agree that if cast-iron wheels are to be used they should be manufactured in accordance with carefully drawn specifications, and should be subjected to thorough test before use. The statement made by Mr. BARR of the Chicago, Milwaukee & St Paul Railway that nine tenths of the cast-iron wheels in use would fail to conform to such specifications as should properly be made, is startling, but without doubt true. Statistics seem to prove, moreover, that the best of steel-tired wheels are safer than the best of cast-iron wheels. It is certainly an element in favor of the steel-tired wheel that it will do the work of between 5 and 10 cast-iron wheels. The degree of danger rapidly increases as a wheel approaches the condition of being worn out. This danger recurs in the case of cast-iron wheels 5 or 10 times as often as in the case of steel-tired wheels, and the safety of the passengers is therefore, in the case of the cast-iron wheel, to a much greater degree dependent upon thoroughness of inspection. The managers of the main lines of road in this State generally agree that the steel-tired wheel is the safer and better wheel for passenger service.

In the return made by the Boston & Maine Railroad Company to this Board it appears that on its western, eastern and northern divisions it has 530 steel-tired wheels in use, and that none of these were broken or cracked during the past year, and that of the 3,748 chilled wheels in use on those divisions 18 were found to be broken or cracked. This is about 4.8 per 1,000, being a slightly higher percentage than that reported by the Pennsylvania Railroad Company. The Atchison road, however, which uses steel-tired wheels only in its passenger service, reports only 4 failures during the year out of 3,866 wheels on passenger cars, or at the rate of about 1 in 1,000; while the Boston & Albany Railroad, with 2,732 steel-tired wheels, reports not a single failure from breaks or cracks. These differences in results may be attributed to differences in road-bed or to greater care in inspection, but they should serve as a guide-post to the goal of safety.

The indications derived from statistics in this country that the steel-tired wheel is the safer are abundantly confirmed by the returns of the English roads. From the reports of the British Board of Trade it appears that in Great Britain chilled cast-iron wheels are not used. The body of the wheel is made of wrought iron or wood, and the tire of wrought-iron or steel. An essential feature of the wheel is the retaining ring, clip or other device, by which the pieces of the tire are kept in place after breakage. So far as the body or core of the wheel is concerned, substantially absolute safety has been obtained.

We are indebted to Prof. C. F. ALLEN of the Massachusetts Institute of Technology for the following deductions from said reports. During the past 10 years the total failures of passenger car wheels in Great Britain have been only 104, an average of about 10 per year, or one failure per annum out of every 15,000 wheels. For the past 7½ years not a single person has been killed or injured from failure of tires, and for 11¾ years none have been killed and only 5 injured.

The relative cost of steel-tired and chilled wheels has long been in dispute. The following figures prepared by Prof. GEORGE F. SWAIN are submitted to furnish a basis for estimates in regard to the relative cost of the different classes of wheels. Take two classes of cast-iron wheels:—

1. Price, $10; cost of fitting and removing, $1. Value as scrap, $5. Mileage, 30,000 miles—1 year (assuming the daily mileage as about 85 miles). Then, at 4 per cent., the present capital necessary to renew this wheel indefinitely is $159.50.

2. Price, $12.50; cost of fitting, $1. Value as scrap, $6. Mileage, 60,000 miles—2 years. Then, at 4 per cent., the capital required to renew this wheel indefinitely is $104.50.

Now find how much, with the same present capital, could be paid for a steel-tired wheel renewing it indefinitely. Take four classes of steel-tired wheels:—

a. A wheel not to be re-tired; 4 turnings at 60,000 miles, or 2 years' service for each turning,—total mileage, 240,000 miles. Cost of turning, $1 every 2 years (a very low estimate). Value as scrap, $10 every 8 years.

b. A wheel not to be re-tired; 4 turnings at 120,000 miles, or 4 years service for each turning,—total mileage, 480,000 miles. Cost of turning, $1 every 4 years. Value as scrap, $10 every 16 years.

c. A wheel to be re-tired; center indestructible; 4 turnings at 60,000 miles, or 2 years' service for each turning. Total mileage, 240,000 miles,—8 years. Cost of turning, $1 every 2 years. Cost of re-tiring, $30 every 8 years.

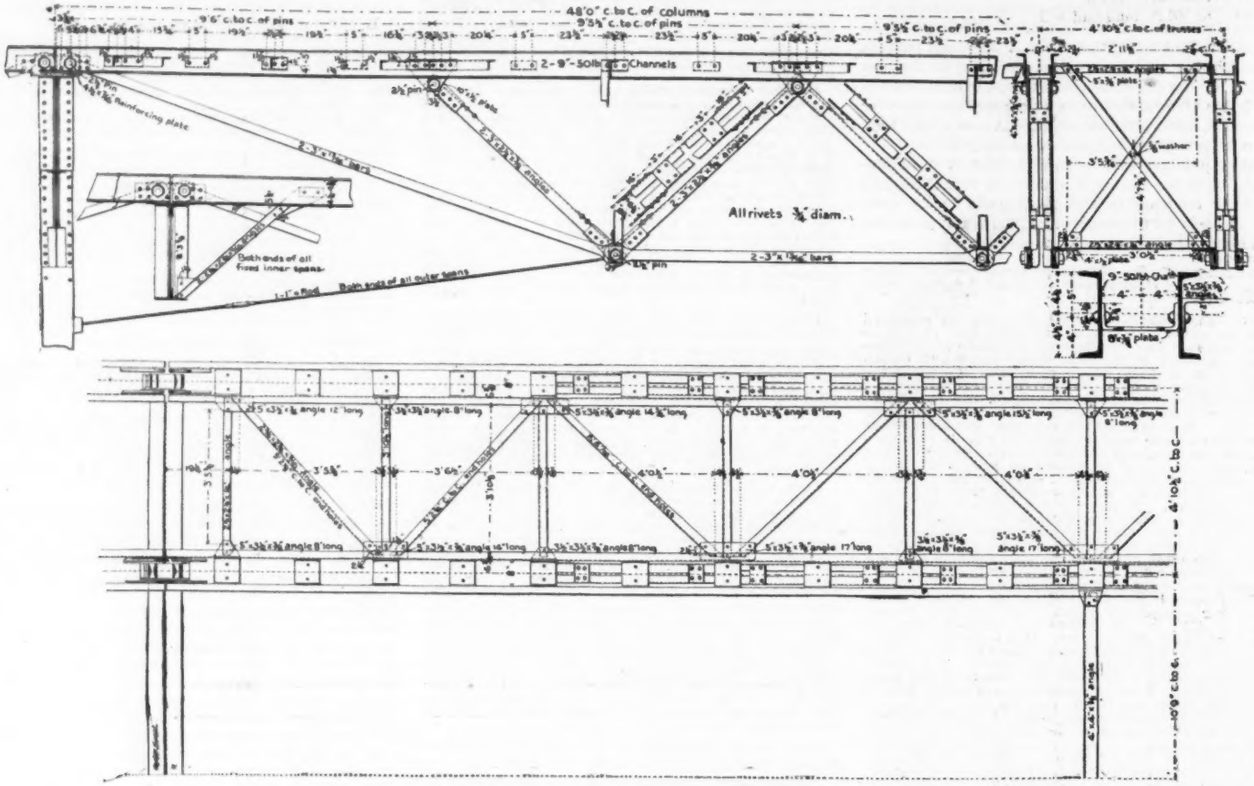
d. A wheel to be re-tired; center indestructible; 5 turnings at 90,000 miles, or 3 years' service for each turning. Total mileage, 450,000 miles,—15 years. Cost of turning, $1 every 3 years. Cost of re-tiring, $50 every 15 years.

The following table gives the price which could be paid for the four classes of steel-tired wheels, *a, b, c, d,* using the same capital as is necessary for the respective classes of cast-iron wheels, interest being reckoned at 4 per cent:

STEEL-TIRED WHEELS.	CAST-IRON WHEELS.	
	Class 1.	Class 2.
Class *a*, ...	$47 00	$32 00
b, ...	77 00	51 00
c, ...	69 00	13 60
d, ...	90 00	36 00

Remembering that the cost of steel-tired wheels is generally over $50.00, it is clear from these figures that a cast-iron wheel of Class 2, *i. e.*, one which, costing $12.50, would last for a period of 2 years, would be considerably more economical than any of the steel-tired wheels considered, excepting Class B, of which the mileage is assumed to be 480,000. This average mileage has not yet, however, been attained. On the other hand, while some authorities claim that the mileage of good cast-iron wheels, under passenger traffic, will not exceed 30,000 miles on the average, other authorities state that it will run up to 50,000 or 60,000 miles.

Comparing steel-tired wheels with cast-iron wheels of Class 1, there is but little difference in cost. It cannot, therefore, be absolutely true that cast-iron wheels are cheaper than steel-tired wheels. Some classes of cast-iron wheels are cheaper than some classes of steel-tired wheels, and the reverse is also true. The difference is not such as to override questions of comfort, convenience and safety.



Detailed Plan and Elevation of Main Trusses.
Inter-State Rapid Transit Railway. ROBERT GILLHAM, Engineer.

The Inter-State Rapid Transit Railway.

We conclude in this issue our illustrations of the Kansas City elevated railway—of which other drawings and data have already been given in our issues of April 21 and 28 and May 12—giving the details of the various parts of the superstructure.

Each span was attached to the support at one end through a slotted hole admitting 2½ ins., extreme longitudinal movement. The adjustable ties connecting the bottoms of the end posts with the columns were designed to give continuity to the structure, and to meet local longitudinal strains due to friction and other causes. It has once occurred since the completion of the structure that the accumulated contraction over about 1,000 ft. of the road made it necessary to relieve these ties by means of the turnbuckles.

It is stated that the structure was designed with a view to darkening the streets as little as possible and it was for this purpose that cross ties were omitted, as shown in our issue of April 28. We are not informed whether the company's charter permits it to add a third track, at the center of the cross girders; but if this is not the case, it would have greatly helped the appearance of the street if the main trusses had been placed over the center of the supporting columns, and the heavy 30 in. cross girders had been replaced by light stiffening trusses which would thus have only been strained by lateral forces.

In reference to the main trusses carrying the tracks, however, it seems certain that the best practice would incline toward the use of riveted plate girders instead of pin connected trusses as superior in economy, safety and durability. It would necessitate shorter spans and more columns in the streets, and would interfere with uniformity by requiring trusses at the street crossings; but the obstruction from the added columns in the row is of little importance, and the advantages for short spans, of the girder over the truss in simplicity, durability, stiffness, freedom from vibration and noise, and staunchness in case of derailments are now generally conceded. As to the question of relative cost, no hard and fast rule can be given that will meet the varying circumstances of different cases, and it must be an open question in each case at what length of span the cost of the extra metal in the girder overbalances the increased work required in making and erecting the truss. It is obvious, however, that questions of economy alone should not prevail in structures of this nature.

Doubtless the detailed circumstances of this case justified the use of the truss rather than the girder; and our comment refers, therefore, to the general principles governing the design of structures of this sort rather that to this particular one.

The Inter-State Rapid Transit Railway was first projected in the fall of 1884. Work was begun in March, 1886, and the road was put in operation 8 months later. The structure as built comprises 1¾ miles of elevated road, of which a small portion is a timber trestle, and 4¾ miles of surface road. Since completion it has been found necessary, in order to obtain a proper entrance to the business center of Kansas City, Mo., to construct a short extension, passing by a tunnel through the bluff and operated as a cable road.

Mr. ROBERT GILLHAM was the Engineer of the road, and the late C. SHALER SMITH was Consulting Engineer. The Edge Moor Iron Co. were contractors for the superstructure, the cost of which was about $24.00 per lin. ft., which is extremely cheap.

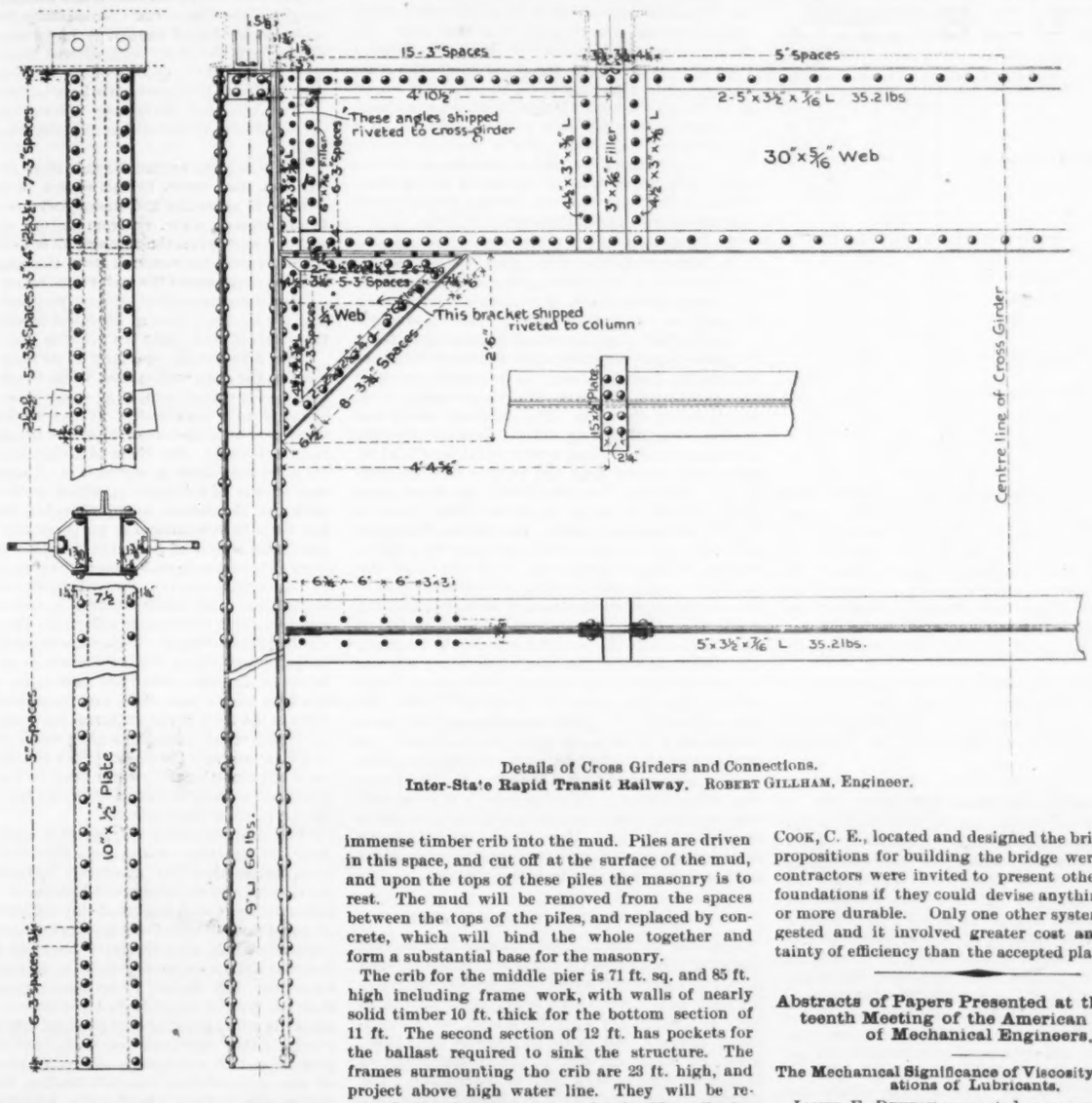
BRONZE images, remarkable on account of their size, age and the method of their construction, are among the curiosities of Japan. One of the largest, said by an old official to have been erected about the year 1100, is 53.5 ft. high and 28.7 ft. across the shoulders. It is surrounded by a halo 78 ft. in diameter. The total weight of the main figure is about 450 tons. This large image is built up of small, irregular pieces of metal joined by a cement called *handaru* by the natives, which has taken the same tarnish as the metal, and shows no signs of decay, which makes it extremely hard to detect the joints.

The Thames River Bridge.

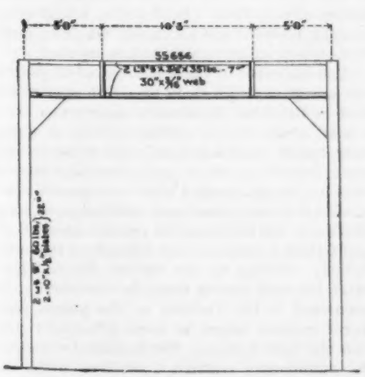
The new double-track draw bridge over the Thames river at New London, on the line of the New York, Providence & Boston Railroad, upon which work has just been started, will be one of the largest draw bridges in the world, and will require about two years for its completion.

The draw will be 502 ft. long and will afford two clear passageways, each having a length of 225 ft. This length of draw was required by the Government, that there might be nothing to obstruct the passage of the vessels to and from the navy yard above. The spans adjacent to the draw will each be 310 ft. long, and the end spans 150 ft. each, making the total length of the bridge 1422 ft. The superstructure will be entirely of steel.

The foundations will be built in water varying in depth from 5 to 57 ft., with from 10 ft. to 80 ft. of soft mud under it. At the abutments and piers adjacent to them the depth of mud and water is not great, but at the other piers it is from 100 ft. to 130 ft. The plan adopted for securing a good foundation under these unfavorable conditions is to sink an immense timber crib into the mud. Piles are driven in this space, and cut off at the surface of the mud, and upon the tops of these piles the masonry is to rest. The mud will be removed from the spaces between the tops of the piles, and replaced by concrete, which will bind the whole together and form a substantial base for the masonry.



Details of Cross Girders and Connections.
Inter-State Rapid Transit Railway. ROBERT GILLHAM, Engineer.



The crib for the middle pier is 71 ft. sq. and 85 ft. high including frame work, with walls of nearly solid timber 10 ft. thick for the bottom section of 11 ft. The second section of 12 ft. has pockets for the ballast required to sink the structure. The frames surmounting the crib are 23 ft. high, and project above high water line. They will be removed after the piers are completed. The cribs for the other two inner piers are 49×79 ft. and 79 ft. and 69 ft. high, including frames. There are 16 cells 12 ft. sq. in the larger crib and 8 cells 14 ft. sq. in each of the smaller ones. As soon as the cribs rest upon the bottom of the river the mud will be removed from these cells by dredges until they have settled about 20 ft. into the mud. The masonry will be built in open caissons, and the bottoms of these will form the grillage upon which the masonry rests. The bottom course of the grillage for the middle pier will be 51 ft. square, and the top course 48 ft. square. The bottom course of masonry will be 42 ft. square, stepping up in 2 ft. courses to 38 ft. square, when it will change to cylindrical from 38 ft. in diameter. The total height of this pier will be more than 75 ft. The other piers will be about 50 ft. by 20 ft. at the base, 90 ft. and 75 ft. high, and will be built in a similar manner. All the masonry is to be of first class granite.

The clear headway under the bridge will be 32 ft., sufficient to allow small vessels to pass without opening the draw. The draw will be mounted on steel wheels and will be operated by steam, and will be reversible so as to follow the vessel passing through, thus saving a great deal of time. The weight of the draw will be about 12,000 tons. Pratt trusses are used and the bridge is designed to carry a live load of 3,000 lbs. per ft. of track. The two end spans of 150 ft. will be the only deck-spans used.

The contract has been let to the Union Bridge Company, of New York and they have sublet the substructure to ALEXANDER MCGAW of Philadelphia.

Mr. A. P. BOLLER of New York, assisted by C. L. COOK, C. E., located and designed the bridge. When propositions for building the bridge were solicited, contractors were invited to present other plans for foundations if they could devise anything cheaper or more durable. Only one other system was suggested and it involved greater cost and less certainty of efficiency than the accepted plan.

Abstracts of Papers Presented at the Seventeenth Meeting of the American Society of Mechanical Engineers.

The Mechanical Significance of Viscosity Determinations of Lubricants.

JAMES E. DENTON presented a paper on the recently developed methods of testing the viscosity of oils, with drawings of 3 "viscosimeters" and 2 tables of which we make the following abstract: Most viscosimeters are simply devices for permitting oil to flow from a reservoir, the time required being the measure of viscosity. The instrument used by Mr. SAYBOLT of the Standard Oil Co. has an outlet $\frac{1}{16}$-in. in diameter. The reservoir holds 4 oz. oil, and is surrounded by a water bath. Both the inner and outer vessels are of glass, so that the fall of the oil can be noted. The oil is brought to the proper temperature by injecting steam into the bath.

Another instrument, devised by Mr. DAVIDSON, permits a higher temperature, the oil and bath being heated by a lamp. The head of oil is kept constant by drawing from a surplus reservoir, and the time required for a given quantity to flow through the orifice is determined. Mr. C. M. PERKINS has designed a viscosimeter so sensitive that the viscosities of illuminating oils may be determined by it. A piston is allowed to fall through a cylinder filled with oil and the time required for a given fall is taken as the measure of viscosity. The piston is $\frac{1}{1000}$ of an inch less in diameter than the cylinder. Results obtained by these instruments show a fair

agreement. Calling the viscosity of pure petroleum heavy cylinder oil 1.00, we have by the three instruments castor oil .60, .51, .67; lard .23, .30, .22; sperm .18, .26, .15; and paraffine spindle oil .15, .23, .10. The temperature was 167° Fah.

The results of tests made on an upright engine with 90 sq. in. area of crosshead shoes on the working side under a pressure per square inch of nearly 140 lbs., stroke 36 in., and making about 80 revolutions per minute, are given in the table.

Relative Amounts of Oil Used Per Minute on Engine Slides Under Heavy Pressure Compared With Relative Average Viscosities.

Description of Oils.	Relative amounts of oil required per minute to prevent wear of brass crosshead shoe.	Reciprocals of relative viscosities from average of 3 tests.
Heavy cylinder oil, pure petroleum	1.0	1.0
Mixed oil { 90% Pure petroleum / 10% Neatsfoot	1.6	1.61
Castor oil	1.8	1.66
Mixed oil { 70% Petroleum / 30% Animal	1.6	1.90
Mixed oil { ⅓ Paraffine / ⅔ Heavy cylinder oil	1.9	2.50
Lard oil	4.5	4.00
Tallow	4.6	3.40
Sperm	4.6	5.00
Light paraffine, spindle oil	60.0	6.00

Enough of each kind of oil was supplied to keep the bearing surfaces the same distance apart throughout the entire test. In the case of the very light paraffine it is supposed that the pressure was too great to allow a sufficient amount to get between the bearing surfaces, and that most of the oil used flowed over the advancing edge of the crosshead shoe. Before being applied the oil was raised to the temperature of the surfaces in contact, 167° Fah.

The general conclusion from these experiments is that the most economical lubricant for heavy machinery where the loss of power due to friction is of minor importance, is the oil of greatest viscosity which can be fed.

Proportioning Steam Cylinders.

Prof. THURSTON pointed out some of the most important considerations in designing cylinders. Modification of heat-wastes determines the best form of cylinder; the cost of construction influences the type and proportions of an engine required to develop a certain amount of power; the financial conditions of continuous operation, the most important consideration of all, determine how large an engine can be profitably employed under the existing conditions. As a rule the larger the engine the less the cost of building per horse power developed; and the shorter the stroke the shorter the engine and the less the cost of construction. There is a certain definite relation between length of stroke and diameter of cylinder, for which the efficiency of the working fluid is greatest. This ratio is determined by considering the minimum cylinder condensation and internal wastes of heat, and the time of exposure of the surfaces to the action of steam and exhaust. The ratio of stroke to diameter found to be best is from 1 to 2. For high speeds 1 to 1.5, and 1.5 to 2 for slow-going engines. When this ratio has been selected, the net horse power required is determined, and this divided by the efficiency gives the indicated horse power. With this data the cylinder diameter may be readily found by a formula, for which the coefficients have been tabulated.

The Effect of Circulation in Steam Boilers on the Quality of the Steam.

In this paper GEO. H. BARRUS explained the peculiar behavior of a small boiler used for steam heating, and the simple means employed to correct its faults.

The boiler consisted of a plain vertical shell 40 ins. in diameter and 48 ins. in height. It contained 115 2-in. tubes 4 ft. long, and was supported by a brick furnace which contained a grate 33 ins. square, placed 24 ins. below the lower head. A smoke bonnet having a side flue 12 ins. in diameter carried the gases to a brick chimney close by, which was 40 ft. high. The side flue contained a damper operated by an automatic regulator set to close at a pressure of about 5 lbs. The shell was covered with fossil meal. The heating apparatus was constructed on the low-pressure gravity-return system. The total extent of radiating surface amounted to 900 sq. ft. The lowest point of this surface was at a horizontal distance of 100 ft. from the boiler, measured along the return pipe, and this point was 18 ins. above the usual water line. The highest point was 14 ft. above the water line. The main steam supply pipe was a 2½-in. pipe, and led off from the upper head of the boiler, near one side. The main return pipe was a 1¼-in. pipe and at a point beyond the check valve it was increased to 2 ins., and entered the boiler through the bottom head. The upper ends of the tubes in the boiler were provided with cast-iron ferrules with openings through them ¾ in. in diameter.

The boiler was filled until, with a low fire, the water stood at the top of the glass. When the fire was started up the water gradually fell, reaching the bottom of the glass, 12 ins. below the top, when the plant was in normal action. There was ample evidence of priming, the sound of rushing water in the main pipe being distinctly audible. When the automatic damper closed, momentarily checking the production of steam, the water rushed back, nearly filling the glass. The radiators lowest and farthest away filled with water. Repeated blowing off and changing water produced no beneficial effects and showed that the trouble did not arise from bad water. Two additional 2-in. steam pipes were inserted as far as the tubes, being placed as high in the shell as possible, and having the upper part cut away to make them take steam from above, but this did not help matters. Next the boiler was treated to a large dose of soda, but this also failed to give relief, although the priming seemed less serious while the alkaline liquor was in use. At last it was decided that the priming was due to improper circulation, and the plan adopted to improve it was to remove some of the ferrules in the center of the boiler. The total area of the openings of these ferrules was 0.35 sq. ft., which bears a ratio to the grate surface of 1 to 21.6. By removing 36 ferrules the area was increased to 0.84 sq. ft., the ratio to grate surface now being 1 to 9. The effect of this change was instantaneous. Priming ceased at once, and the water line remained nearly constant, the variation being only 2 ins. There was no further trouble in draining radiators and pipes and the apparatus gave perfect satisfaction from this time on.

Estimating the Cost of Foundry Work.

The author Mr. GEO. L. FOWLER, said that the only correct way is to make a detailed estimate of each heat, and ascertain the cost of each individual casting; and he outlines a plan requiring an hour to an hour and a half for a 5 to 7 ton heat for miscellaneous castings, and 15 to 20 minutes for "line" work, by which the cost to the manufacturer of each individual casting may be determined. The old method of taking weight as a basis, and dividing the total expenses for wages, iron, fuel, rent, moulding material and incidentals for a certain length of time by the total output for the same time, thus obtaining the price per pound at which to sell all castings, is manifestly incorrect, as a light casting may require more expense in moulding than a heavy one. The proper basis upon which to found estimates is the cost of moulding, and to this should be coupled a careful consideration of weights, and the cost of iron and fuel. Under the two heads of weight and moulders' wages we group all the expenses of the establishment. The cost of melting, cost of iron and fuel, service of cupola, clearing drop and cleaning castings depend upon the weight. Under the head of moulders' wages all other expenses are brought, including expense for clerks, helpers, superindendence, moulding materials, etc. We determine the ratio of all these minor items to the moulders wages. The time spent by the moulder on each piece of work is ascertained by the timekeeper, his wages for the time are multiplied by 1 plus the sum of all the ratios, and the cost of the iron in the casting is added, the sum being the cost of that casting.

Sub-Surface Waters for Cities.*

Prof. A. A. BRENEMAN spoke as follows:

"Every plan for supplying water for domestic use to cities must be regarded from the standpoint of the chemist, as well as from that of the engineer. Unfortunately for sanitary interests it often happens that the chemist is called in only when some glaring defect in the operation of a system is met with which might have been prevented if his counsel had been sought at the beginning. Considerations of quantity and permanence of supply, so important in themselves, have too often been allowed to overshadow the question of the quality of the water to be used. As a result of this policy, we have to face the fact that not one-tenth of the large cities of this country are supplied with water that is really wholesome or good.

"There is some excuse for this state of things in the fact that resort to the waters of rivers and streams is generally had under pressure of danger from polluted wells, or from failure of previous sources; and when the new system is decided upon there is rarely time enough for a thorough inquiry into the character of the water to be taken.

"It is characteristic of sanitary progress, however, that the tendency toward chemical investigation at the outset in such cases is a growing one.

"The driven well, especially in its later development as the gang well system, seems to offer a cheap and speedy way of supplying water in any desired quantity to a community. It has obvious advantages over an aqueduct or pipe line bringing water from a distance. But there is a chemical question yet to be considered in regard to it. Unless the surface waters of a district in which wells are to be sunk are themselves unobjectionable, the method has little to recommend it for permanent application. The action of powerful pumps, which draw from a limited area such enormous volumes of water as the system must supply will result, eventually, in drawing in all water—surface as well as subterranean—which the vicinity will yield. The increased depth of these wells, as compared with surface wells, is really very slight when we consider the greatly increased draughts which are made upon them. It has been shown that there are considerable variations in the level of the subterranean waters during the action of the pumps in a gang well system, even at a distance from the pipes. Such changes of level must be proportionally greater near the wells. What is to prevent the gravitation of the surface waters to fill the vacuum thus created?

"The compact beds of clay, so often appealed to to shut out all surface water, are a fallacious dependence, unless they are absolutely watertight over great areas and under enormous pressure. It is too much to expect that a layer of clay sufficiently thick or impervious to water will always be found, or that prospectors will go sufficiently far afield to secure for their wells a region of which the surface is above suspicion. The danger to be feared, especially, is that the flow of water from all directions towards the wells will, under the high pressure created by the pumps, follow only larger pores and crevices underground, and by continually enlarging these, create in time a system of channels leading directly to sources of pollution. Such action would annul the filtering power of the soil, upon which so much depends where subterranean waters are used.

"The operation of the great system of gang wells, which now supplies about one-sixth of all the water used in Brooklyn, illustrates these principles upon a large scale. Seven million gallons of water are daily drawn from a system of 100 wells, varying in depth from 45 to 100 ft. and covering a line about 400 ft. in length. Such a yield corresponds to a total rainfall of 32 ins. a year upon 3,000 acres, or, roughly, represents the same annual rainfall upon all of the land within a radius of 1¼ miles from the pumping station. Owing to the sudden demand for this water, the soil waters must be continually drawn downward in the vicinity of the pumps, and the nearer regions must be more effectually drained than the more remote. The predicted consequences are abundantly realized. Shallow wells in the neighborhood are wholly or nearly dry since the pumping station has been opened. A swamp, form-

*From the discussion of Prof. W. P. TROWBRIDGE's paper on "Subsurface Water Supply for Cities and Towns," in Transactions of the New York Academy of Sciences. Vol. VI., Page 77.

erly existing about the station, has been dried up. The subsoil of the Jewish cemetery, 370 yds. distant, which offers frequent opportunities for observation, is said by the sexton to be much drier than heretofore. The existence of filthy barnyards and open-house drains close to the wells, and of richly manured fields all around them, are suggestive features of the case.

"Chemical analyses of the water from these wells show an abundance of nitrates, the sure indications of organic decomposition.

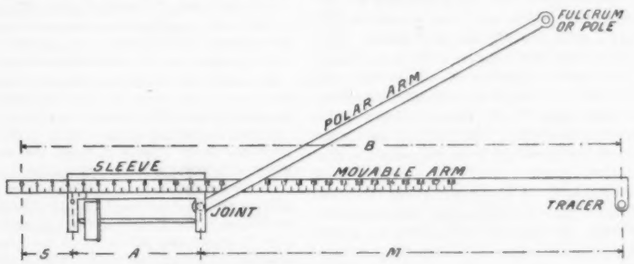
"The gang well system may be, under proper precautions, of great benefit to communities seeking new supplies of water, but it is open to abuses in its application which render it hardly less safe in the long run than the ordinary well. From a very large number of analyses of the water of small driven wells, made by myself, I am convinced that the causes of deterioration in such wells rest also upon the principles already outlined."

Setting the Polar Planimeter by Computation.

BY E. A. GIESELER, C. E.

Settings for the polar planimeter are ordinarily obtained by means of a trial disk, the grooved rim of which incloses a known area, around which the tracer of the instrument can be carried with exactitude.

If two settings of the instrument are reliably known, then the tedious process of using the trial disk can be dispensed with and any further settings can be obtained by computation, provided that the movable arm is furnished with a continuous graduation, which is set to a vernier or a simple zero mark engraved on the sleeve, as shown in the above diagram.



Graduated Planimeter.

The fundamental equation of the polar planimeter for *outside* positions of the fulcrum is:

$$Area = M\,R$$

wherein M = length of movable arm from tracer to joint, and R = wheel record. Denoting the diameter of the wheel with w, then we have for n revolutions

$$R = n\,w\,\pi$$

and introducing this into our first equation we obtain.

(1) $$Area = M\,n\,w\,\pi$$

Now let S be the distance from the zero of the graduation on the movable arm to the zero of the vernier engraved on the sleeve, that is, the "setting" or "adjustment" of the instrument; again, let A be the distance from the zero of the vernier to the joint, and lastly, let B be the distance from the zero of the graduation to the tracer, then we clearly have for M, the distance from joint to tracer, or the length of the movable arm:

$$M = B - A - S$$

and substituting this in equation (1) we obtain

$$Area = (B - A - S)\,n\,w\,\pi$$

or for $n = 1$, that is for one entire revolution of the wheel:

(2) $$Area = (B - A - S)\,w\,\pi$$

and hence

(3) $$w\,\pi = \frac{Area}{B - A - S}$$

(4) $$S = B - A - \frac{Area}{w\,\pi}$$

By means of equation (3) we can compute the value of $B - A$ and $w\,\pi$ for any given instrument, if two settings of the same are known, and having once found these values, which are constants for one and the same instrument, we can then by means of equation (4), find the required setting for any desired value of the vernier unit, that is within the scope of the instrument.

A planimeter graduated in this way is now sold at a slight advance by the firm of KEUFFEL & ESSER of this city, and we presume by other makers. The movable arm on this carries a graduation of half millimeters, which is figured as shown in the diagram; in the latter only every fifth line of the graduation is shown; the setting represented therefore reads about 33. The circumference of the wheel is graduated as usual into 100 parts, each of which is subdivided into tens, by means of the vernier; one entire revolution of the wheel is therefore equivalent to 1,000 vernier units. A table giving seven settings for English measurement and as many for metric measurement accompanies each instrument.

Suppose now we take from this table $S = 27.9$ for a value of vernier unit of 10 sq.^{m} in a scale of 1 : 1000, which is equivalent to an *actual value* of vernier unit of 10 sq.^{mm} in a scale of 1 : 1; again $S^1 = 222.4$ for a value of vernier unit of 1 sq.^{m} in a scale of 1 : 500, which is equivalent to an *actual value* of vernier unit of 4 sq.^{mm} in a scale of 1 : 1; then for S, one entire revolution of the wheel represents an area of 10000 sq.^{mm}, while for S^1 it represents an area of 4000 sq.^{mm}. Substituting these values in equation (3), we obtain

$$\frac{10000}{B - A - 27.9} = \frac{4000}{B - A - 222.4}$$

consequently $B - A = 352.1$, and by means of this value equation (3) renders:

$$w\,\pi = \frac{10000}{352.1 - 27.9} = 30843$$

Suppose now it is desired to find the setting at which the vernier unit of the above instrument is equal to 5 sq. ft. in a scale of 20 ft. to 1 in., or, in other words at which the *actual value* of the vernier unit in a scale of 1 : 1 is equal to 0.0125 sq. ins. or 8.0645 sq.^{mm}, then one entire revolution of the wheel will represent an area of 8064.5 sq.^{mm}, and introducing this and the above obtained values for $w\,\pi$ and $B - A$ into equation (4), we find

$$S = 352.1 - \frac{8064.5}{30.843} = 352.1 - 261.4 = 90.7$$

which is the required setting.

Equation (2) can be utilized to determine the extreme limits of the values of the vernier unit for each instrument. Suppose that in the above example the graduation on the movable arm runs up to 280, then we clearly have

Smallest possible $S = 0$

Greatest possible $S = 280$

and substituting these two extreme values successively in equation (2) we obtain

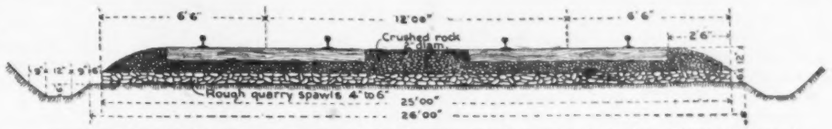
Area = (352.1) 30.843 = 10860 sq. ^{mm} and

Area = (35.21 − 280) 30.843 = 2224 sq. ^{mm}

This instrument, therefore, can be set to any value of vernier unit lying between 10.86 sq. mm 0.01688 sq. ins. and 2.22 sq. ^{mm} = 0.00344 sq. ins.

Standard Stone Ballasted Track, New York Central & Hudson River Railroad.

The New York Central has heretofore used but little stone ballast on its road, but a considerable stretch of it is now to be laid down, however, in connection with the 80 lb. rails and new joint illustrated in our issue of April 21, and we understand that it is likely to be much more used hereafter. The section which we illustrate has been adopted as the standard for such track on double track sections. The quadruple track section necessarily varies according to circumstances.



Standard Roadbed for Stone Ballasted Track. New York Central & Hudson River Railroad.
WALTER KATTE, Chief Engineer.

The space between centers of track will be seen to be smaller by about a foot than what may be called the standard, which we presume is an incident to the quadruple track system. It is, however, sufficient to enable a man to stand safely between two passing trains, although most men would rather not do it.

That stone ballast track is easier on joints than gravel, is proved in a convincing manner by a lot of joints removed from the West Shore Railroad for examination after four years service, partly on gravel and partly on stone ballast, and now in the Chief Engineer's office. As we have already noted, none of these joints show serious deterioration, but the joints from stone ballast are, so far as the eye can observe, almost wholly unworn, while the deterioration of the gravel-ballast joints is distinctly observable, although not yet serious. There is still a large party which stands by gravel ballast as preferable in itself as well as cheaper, but we think a candid examination of the evidence should convince anyone that broken stone is the best, and in the end the cheapest as well, for heavy traffic.

High Walls or Dams to Resist the Pressure of Water.

[*Abstract of paper by* JAMES B. FRANCIS, *Past President Am. Soc. C. E., presented to the Society May* 16, 1888, *as elsewhere noted*].

In recent investigations the crushing strength of the material of a wall is made the controlling factor, and if this factor is determined under the same conditions existing when it is applied there is no objection to this method. The mortar is usually weaker than the stone. If made of Portland cement, well set, its resistance to crushing may be assumed as 2,000 lbs. per sq. in. Engineers assume as a safe load, in ordinary masonry $\frac{1}{10}$ of the breaking weight, and in rubble masonry $\frac{1}{8}$ or $\frac{1}{9}$. This gives for ordinary masonry an admissible pressure of 200 lbs. per sq. in., which is about the maximum in existing walls.

The laws of resistance to crushing deduced for small specimens cannot properly be extended to large masses. Two-inch cubes of granite are crushed under a weight of 24,000 lbs. per sq. in., about equivalent to a column 1 in. sq. and 4 miles high. If this law would apply, granite and other formations solid at the earth's surface would be crushed at a depth of 4 miles; but in the light of experience we should expect to find materials at that depth as sound as anywhere. In a large mass there is a lateral support from the surrounding material which does not exist in small specimens. In the interior of a large mass, great pressure reduces the volume, but the horizontal dimensions remain unchanged, and fracture does not occur on that account.

Gen. GILLMORE found that the resistance to crushing per square inch of surface increased rapidly with the area subjected to pressure, and the results of some of his experiments are given in the accompanying table. The increased strength of a 2 in. over a 1-in. block of the same thickness must be mainly due to the central portion, since the boundaries are under the same conditions in each case. If the resistance increased uniformly from the edge of the cube to its center, the total resistance to crush-

ing would be represented by a pyramid with base equal to the surface of the cube, and to make the volumes equal the altitude of the pyramid must be three times the height of the cube. This makes the resistance at the center three times the average resistance of the cube. It will, however, be more rational to assume that the law of resistance is represented by a curve, some of the characteristics of which are that it shall be symmetrical about the vertical axis where, also, the maximum ordinate will be found. The ordinates at the edges of the cube must be small and a tangent to the curve at its vertex must be perpendicular to the axis.

Assuming this curve to be a parabola, the maximum ordinate would be twice the mean ordinate; if it is a semi-ellipse, the maximum ordinate will be 1½ times the mean ordinate. Assuming the curve to be a parabola, the strength at the center is twice the average strength of the cube, which is probably about correct. The blocks were compressed between

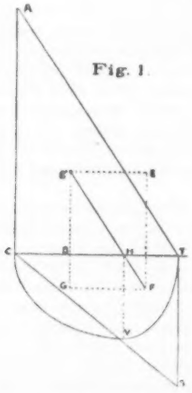


Fig. 1.

Diagram of Resultant Pressures on Base of Dam

wooden cushions of the same area as the stone, and $\frac{1}{16}$ in. to $\frac{5}{8}$ in. in thickness. The average results were found by Gen. GILLMORE to be closely approached by the formula $y = 7000\sqrt[3]{x}$, in which y is the compressive strength in lbs. per sq. in., and x is the side of the cube in inches.

Compressive Strength of Gray Berea Sandstone.

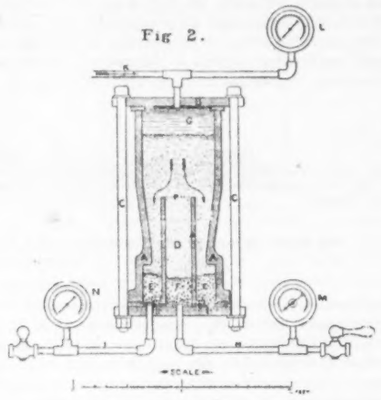
Side of cube. Ins.	No. of cubes tested.	Average compressive strength per sq. in. Lbs.	Compressive strength computed by the formula, $y = 7000\sqrt[3]{x}$ Lbs. per sq. in.
0·25	8	4,992	4,410
0·50	10	6 080	5,558
0·75	7	6,347	6,356
1·00	9	6,990	7,000
1·25	9	7,342	7,539
1·50	10	8,226	8,015
1·75	9	9,310	8,435
2·00	9	8,955	8,820
2·25	7	9,130	9,170
2·50	10	8,856	9 499
2·75	10	9,838	9,807
3·00	3	10,125	10,095
4 00	1	11 720	11,112

Compressive strength at center of cube is assumed to be double that in the last column.

Cubes of blue Berea sandstone, crushed between hardened steel surfaces gave a resistance of 9,500 lbs. per sq. in. for a 1 in. cube, and 13,300 lbs. per sq. in. for a 2¼ in. cube, the compressive strength being given very closely by the formula $y = 9500\sqrt[3]{x}$. Assuming the resistance at the middle to be twice the mean, we have for a 1 in. cube a maximum resistance of 19,000 lbs. per sq. in., and for a 2 in.cube a maximum resistance of 23,940 lbs. per sq. in.

The strength of Portland cement is shown by the experiments of JOHN GRANT quoted below. Blocks of Portland cement of different ages, 3 ins. × 3 ins. × 1½ in., were crushed in a hydraulic press, part flat and part on edge. Ten blocks of each age were tested in each position. Eighty blocks crushed on edge, with a surface under pressure of 4.5 sq. ins., average age, 7 days in water, 699 days in air, had a tensile strength of 303 lbs. per sq. in., and a compressive strength of 4,654 lbs. per sq. in. Seventy blocks crushed flat, area pressed 9 sq. ins., average age in water 7 days, in air 666 days, had an average tensile strength of 327 lbs. per sq. in. and a compressive strength of 5,882 lbs. per sq. in. A comparison of the two results shows that the blocks crushed flat, with double the area and half the thickness, have a resistance to compression per square inch 11

Fig. 2.



Apparatus for Testing Porosity of Mortar.

per cent. greater than those crushed on edge. In these experiments it would seem that an equal pressure per square inch had been applied to the whole surface of the block, and this would be the case if the block was a perfectly rigid mass. But even stone and cement are compressible to a certain extent, and since the resistance to compression is greatest at the center, it requires a greater pressure there than at the edges to produce uniform compression in the whole block. The effect of this is to transfer a part of the pressure from the edges to the central parts of the block.

Experiments made by H. GOLLNER, show that the crushing strength per square inch of cubes is only about 72 per cent. of that of cylinders; in other words, the angles of the cube projecting beyond the inscribed circle add nothing at all to the strength of the block. The general principle deduced is, that different parts of a mass yield unequally, the effect being to transfer pressure from the yielding parts to those that are firmer. Such a transfer of pressure takes place in tunnels through rock, where no timbering is required to support the roof before the masonry lining is completed.

The two tunnels for supplying Chicago with water extend about two miles under Lake Michigan. They are mostly through clay which required no support before the roof was put in, if that was done within 36 hours after the excavation was made. The smaller tunnel is of 5 ft. inside diameter, and supplies 50,000,000 galls. of water per 24 hours. The larger has an internal diameter of 7 ft. and supplies 100,000,000 galls. in 24 hours. The pressure at the level of the center of the tunnels before any excavation was made, was estimated at 5,931 lbs. per sq. ft., which pressure was uniform over an area of indefinite extent. When the excavation was made the support for 9 ft. in width was taken away, so that a pressure of 53,370 lbs. per lin. ft. was transferred to adjacent areas. No settling of the roof was perceptible, though a small yielding of the material must have taken place to allow the pressure to be transferred.

Mr. FRANCIS then goes on to apply the principles deduced to high walls and dams for withstanding water pressure. The dam is assumed to act by its weight alone, to be founded on a rock, and to be built of rubble masonry forming a homogeneous mass, but sufficiently compressible to permit the transmission of excessive pressures to the center of the mass. The three causes of failure considered are overturning, sliding on its base, and the crushing of material.

The most stable form of wall is that whose section is a right angled triangle. As there are no varying stresses, a factor of safety of 2 or even less will be ample to secure the wall against overturning.

There is no possibility of failure from sliding with rubble masonry resting on an uneven base.

To discuss the resistance of the wall to crushing we must determine the maximum pressure and its point of application. According to the method given by DEBAUVE, when the reservoir is full, and the resultant of the pressure of the water and of the weight of the masonry intersects the base at one third of its width from the down-stream toe, the maximum pressure per square inch on the base is at the down-stream toe, and is double what the pressure per square inch would be if the weight was uniformly distributed over the whole width of the base. When the reservoir is empty the conditions are reversed, the maximum pressure being at the up-stream toe, and equal to double the average pressure at the base of the wall. Mr. FRANCIS continues:

In Fig. 1 TS represents the pressure at the down-stream toe, T, when the reservoir is full, according to the method given by DEBAUVE, the pressure at the up-stream toe, C, being zero. The area of the triangle CTS represents the total pressure on the base of the wall, the line CS representing a uniform decrease of pressure on the base from T to C.

According to deductions from experiments, the pressure is mainly transferred from T to the interior of the base, where the resistance to compression is much greater. The pressures at different points may be represented by the ordinates of the curve CVT, the area between it and the line CT being equal to the area of the triangle CTS. I am unable to give the exact form of the curve, but some of its characteristics, to accord with what has been stated, are obvious. The ordinates at C and T must be small; the maximum ordinate must be less than TS, and be either within or near the middle third of the base. The curve CVT has these characteristics, and is composed of quadrants CV and VT of two ellipses, the common ordinate HV at the intersection of the resultant gF with the base CT being 0.6366, TS being unity. The sum of the areas of the two quadrants of ellipses is equal to the area of the triangle CTS, and consequently, represents the total pressure on the base of the wall.

In a wall 400 ft. high, according to DEBAUVE'S method, the maximum pressure is at the down-stream toe, T, where it is 390.64 lbs. per sq. in. If the pressure is distributed according to the curve CVT, the maximum pressure is at V, 88.88 ft. from the down-stream toe, where it is $390.64 \times 0.6366 = 248.68$ lbs. per sq. in.

It will be understood that the curve CVT is given only as an illustration of the distribution of pressures according to the theory advanced, and with no pretension to precision, either as to the distribution or the determination of the point where the pressure is a maximum. It would be desirable to be able to do so, but it is not essential to the present purpose; the main point in reference to the safety of the wall being that the vicinities of the toes are relieved from dangerous pressures by the transfer of a large part of the same to parts of the base capable of sustaining them without danger of crushing.

We have no means of estimating the amount of compression in different parts of the mass; but if the theory of the transfer of pressure which I have attempted to established is admitted, the conclusion must follow that there is no danger from crushing.

In the case of the rock on which the wall is built having seams containing water in communication with the water in the reservoir, by constructing drains sufficiently near to each other in the base of the dam to discharge the water from the seams through the outer toe of the wall, no upward pressure could be communicated to the wall; it would, however, allow some waste of water, and might be objected to as interfering with the homogeneity of the masonry. If drains are not provided, it may be questioned whether the upward pressure would extend beyond the parts of the masonry immediately in contact with the seams. Assuming that the work is as well done as it can be, that is, that all the stones are perfectly bedded in the mortar, and that all the joints are solidly filled with mortar or concrete the question is: Would the upward pressure from the seams be communicated to the entire base of the wall? This involves the question as to whether the pressure of water can be communicated through the capillary channels in the mortar. Not finding anything definite on record on this point, I made the following experiments:

Fig. 2 is a section of the apparatus. The cast-iron case, A A, is an ordinary reducer for the purpose of connecting a 6-in. pipe with a 4-in. pipe. To fit it for this purpose, heads, B B were applied, packed with rubber and kept in place by 4 bolts, 2 of which are shown at C C. An inner pipe, D, 3 ins. interior diameter, is bolted to the head, B, the joint being packed with rubber. The interior of the case A and the pipe D are filled, as represented, with Portland cement mortar, in the proportion of cement 1, and sharp pit sand 2. The mortar was tempered to the usual consistency for use, and was carefully worked into place by churning it with a stick. Spaces E E and F, to receive the water passing through the mortar, were left at the bottom, which were filled with gravel, and covered with cotton

cloth, to prevent the mortar from filling the spaces in the gravel. A space, *G*, was left between the top of the mortar and the upper head, *B*. This space was connected with the system of pipes laid for supplying water for extinguishing fires in the Lowell factories, by the pipe *K*, and the spaces *E E* and *F* were furnished with discharge pipes, *I* and *H*, the outlets of which were furnished with stop cocks or caps. Each of the pipes *K H* and *I* was furnished with pressure gauges *L M* and *N*, as represented in the figure.

It is well known that Portland cement mortar expands in setting under water, which would seem to be a sufficient guarantee that the water would not follow the joint; but, as a further security, the inner pipe *D* was put in, and means provided for testing the percolation of water through it, and the amount of pressure transmitted, independently of that transmitted through the mortar between it and the case.

The experiments consisted in noting the pressures at the several gauges at the beginning and end of periods, which gave sufficient time for them to become established. The pressure at the gauge *L* depended entirely on the pressure in the supply pipe, and was subject to changes of short duration, depending mainly on the drawing of water in a neighboring office. These exchanges were, however, so infrequent and of such short duration, that they had little influence on the results, and no account has been taken of them. The normal pressure at gauge *L* was about 77 lbs., and it is to be so taken in all these experiments.

The cement mortar was mixed and put into the apparatus Feb. 28, 1888, and remained in the air in a cellar, where the average temperature was about 36° F., for 7 days. It was then put into a tub of water, in the same cellar, where it remained 21 days, the temperature of the water averaging 38.3°. The apparatus was then taken out of the tub, and remained in the air another 7 days, the temperature of the air being about 40°. It was then returned to the tub, where it remained another 7 days, the temperature of the water being 40°. It was then taken out, and the mortar having become well hardened, the apparatus was completed for the experiments.

We condense and rearrange the details of these interesting experiments in the following table, which shows at a glance just what results were obtained:

Experiments on the Transmission of Pressure through Hardened Portland Cement Mortar, by JAS. B. FRANCIS, *with the Apparatus shown in Fig.* 2

Number of Ex.	Duration.		Pipe *H.*	Pipe *I.*	Change of Pressure at *M.*	Gauges at *M* and *N* stationary for the final.		Change at *N.*
	Hrs	Min			Lbs.	H.	M.	Lbs.
1	15	15	Closed	Open	0 to 65.5	1	20	——
2	6	11	Closed	Open	0 to 64.	1	30	——
3	19	48	Closed	Open	0 to 62.6	1	—	——
4	6	13	Closed	Open	0 to 59.75	1	26	——
5	13	59	Closed	Open	0 to 57.25	——		——
6	45	32	Closed	Open	0 to 46.5	1	9	——
7	70	42	Closed	Closed	46.5 to 72.5	21	45	——
8	26	33	Closed	Open	72.5 to 39.75	2	42	——
9	72	45	Closed	Closed	39.75 to 73.5	3	18	0 to 71
10	28	10	Open	Closed	——	7	30	71 to 58

Experiments on the Percolation of Water through Portland Cement Mortar 6 to 8 weeks old. Cement 1. *Sharp pit sand* 2. *Block* 15 84 *in. thick.*

No. of Ex.	Duration.		Pipe H.	Pipe I.	Change of Pressure at M.	Pressure at L.	Drip from H.	Drip from I.	Total percolation per 24 hours.
	hours.	min.			lbs.	lbs.	lbs.	lbs.	lbs.
• 1	3	3	Closed	Open	27 to 64	77.	——	1·453	11·433
2	24		Open	Open	——	77.	1·762	8·256	10·018

Mr. FRANCIS adds:

These experiments are on a small scale with an imperfect apparatus; but I think we are justified in inferring from them that pressure can be transmitted through hardened mortar composed of 1 part of Portland cement and 2 parts of sharp pit sand, and that in the base of a wall founded on a rock, having numerous seams containing water under a head, the flow from which not carried off by drains, an upward pressure may be transmitted through the mortar to the entire base.

The experiments on percolation indicate that water under pressure penetrates the mortar, and unless the upstream face of the wall is protected by a water-proof lining, the mass of the masonry would be saturated. What effect saturation would have on the stability of the wall is a question, but it would appear to be an additional reason for draining the base, as it would be difficult to prevent the penetration of water at every point.

Heating and Ventilating System of the Massachusetts Institute of Technology.

In further illustration of the results with the heating and ventilating apparatus of the Massachusetts Institute of Technology, as described in our issues of Feb. 25 and March 3, we add the following diagrams. Fig. 9 is a diagram showing the quantity of water condensed. It also shows the time of turning on steam; and serves as a telltale of the engineer's performance of his duties. A drum carrying a piece of paper is made to revolve once in 24 hours by clock-work, and a pencil is so situated that it draws a line representing the cubic feet of water condensed, from the beginning of the period.

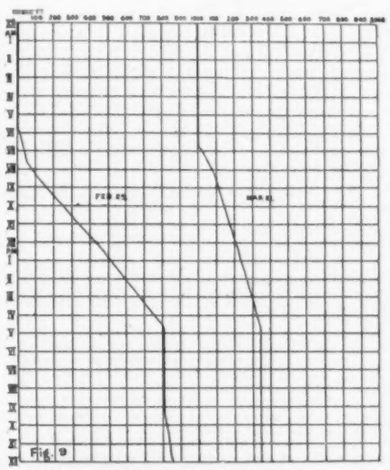


Diagram Showing Condensation of Steam.

A diagram showing the relation of the weather to the consumption of coal and water is given in Fig. 10. The plotted curves show the influence of temperature and high winds upon the amounts of coal and water required. In cold weather it is found that an additional hourly condensation of 1½ cu. ft. of water is required for every degree that the outside temperature falls below 65° Fahr. These weather diagrams are prepared monthly.

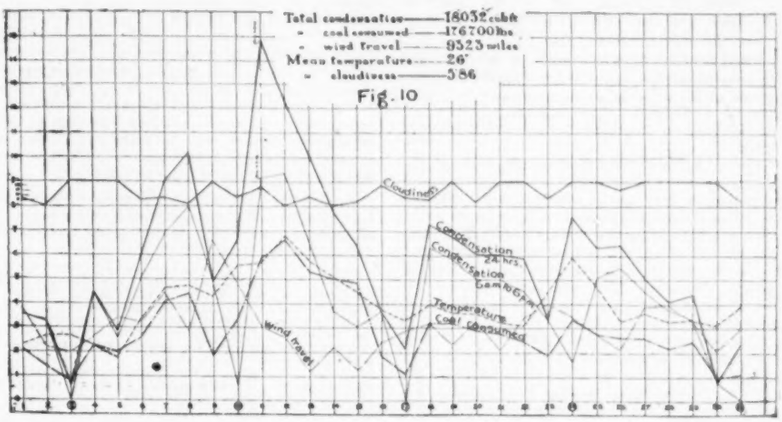


Diagram Showing the Relation of Weather to Coal and Water Consumption.

A Railroad Lobby Investigation in Kentucky.

We are sorry we have not the space to publish the whole of the manly protest which has been made by Messrs. E. B. STAHLMAN, S. R. KNOTT, and B. W. DUKE, officers of the Louisville & Nashville railroad, against the insults and unjust treatment which they have received at the hands of a committee of the Kentucky legislature appointed to investigate the charges that these gentlemen were illegally influencing members of the legislature. They relate minutely the manner in which their character as gentlemen has been impugned and all opportunity to defend themselves denied, and after giving such a statement as must convince any unprejudiced man that they have been subjected to an extremely unjust sort of star chamber tyrrany, they say frankly:

"We were in Frankfort as the committee has asserted, and were seeking to influence railroad legislation. By means, however, which were neither corrupt nor improper, unless explanation or argument fall within that category, and to ends which we deemed not only legitimate and beneficial to the interests we were representing, but also to the best interests of the public.

"The extent to which special legislation is carried in Kentucky, the multitude of laws affecting property interests both corporate and individual, which are proposed, compel all who are charged with the protection of such interests to watch legislation and often seek to restrict it. Upon the part of the larger corporations especially the railroad companies, whose business and prosperity are more usually sensitive to legislative action, and injuriously affected by unwise interference, such care and diligence is absolutely necessary if they would avoid great detriment."

"He who expects men, worthy to be invested with the responsibility of conducting the affairs of great corporations with their manifold interests, and capable of such direction, to quietly submit to usurpation of this nature, even though done by statutory enactment, knows little of the interests involved. The plans of the Railroad Commission as expressed in their report and formulated in a number of bills, were far-reaching and comprehensive, concentrating in their hands power which, if exercised by designing and unscrupulous men, might control the politics of the State. In view of these proposed changes, it is not strange that others beside officers of the railroad companies should recognize the necessity for counteracting the influence brought to bear on the Legislature to concede the demands of the Commissioners. From our standpoint it was essential that the Legislature should rebuke the Commissioners. The legislation they proposed would have demoralized our business, retarded the extension of our lines, created uncertainty concerning the future and practically confiscated property, for the management of which we were responsible. We did use all legitimate influence that we could command in order to protect interests thus threatened. The people of Kentucky are not ready to condemn as a crime in a railway official, what they concede as a right to other citizens."

A Statement by Mr. Thos. C. Clarke.

We reprint below the full text of a statement presented at the last meeting of the Board of Trustees of the Brooklyn Bridge in regard to the terminal question, claiming to be "a complete answer to the attacks upon us (the Terminal Committee) of exaggeration and falsification." The statement will speak for itself, and does not seem to either call for or admit of further discussion than to subjoin to two or three of the more surprising explanatory statements within it, some documents tending to explain how need for explanation has arisen. Our

readers will doubtless find what we do give interesting, and will pardon our declining to attempt to discuss the further statements of the document. Those who have kept the run of past events will understand why it does not seem worth while to do so, and those who have not, will hardly care to begin studying them at this late date.

Mr. CLARKE read the following statement:

This board is asked to reconsider its action at its last meeting, by which it adopted certain terminal plans. If this can be shown to be for the public good, I shall vote for it. At present I can see no reason for questioning the wisdom of their course on the 17th day of last April.

It has been publicly stated that the estimates of our chief engineer were a falsification of fact, and were intended to deceive this Board by exaggerating the cost of a certain patented plan in order to prevent its adoption; the inference being that if this gross charge was true, we should hasten to reconsider our action and adopt that rejected plan, because it is the best that can be devised. Moreover, in order to strengthen this position, I, as an expert member of the late Terminal Committee, am misrepresented as saying that I am in favor of this patented circulatory eighteen car plan, with its manifest absurdities and dangers. I deny this, I look upon it with the utmost distrust. What I did say, and do now repeat, is, that I am in favor of a circulating system which will do away with locomotives. (**a**) So far I agree with the late Board of Experts. What that circulating system is I will explain later.

The rejected patent system is most dangerous, for the reasons given by our chief engineer in his letter of April 10. Can anything be more dangerous than to have a train of eighteen cars full of passengers, (**b**) running down a grade of 170 ft. per mile with another similar train standing only 352 ft. in front of it? Should the grips fail to let go, or the brakes fail to work, the heavy eighteen car train standing on the main track could not be got out of the way in time to prevent a disaster too shocking to contemplate.

This board, I am proud to say, has always placed safety in working, as the first, the last, the only consideration, and the results so far have justified the wisdom of this action. I for one do not intend to leave the path of safety.

About a year ago, when it became evident that means should be taken to increase traffic facilities, a plan was presented to you by an engineer of the highest standing, Mr. C. E. EMERY. Mr. EMERY proposed to lay two distinct sets of rails all over the bridge, which at the end stations should diverge into two parallel tracks with platforms between. So far this plan was entirely safe, but he also proposed to take the trains out in face of and crossing incoming trains. This was undeniably dangerous, and therefore his plan was not adopted. (**c**)

Mr. EMERY, however, is a gentleman and did not think it necessary to accuse the chief engineer and the board, of ignorance, incompetency and fraud because they did not adopt his plans.

The plan adopted by you at the last meeting is like EMERY'S so far as bringing in the trains. To take them to the outbound track it continues the long-used and safe practice of tail-switching. It is absolutely safe. No full trains cross each other, and if an incoming train runs away there is always an empty track for it to run upon.

What future improvement can be made in this? Not to make it safer, for this cannot be done. But instead of switching the trains by locomotives, which are very expensive and noisy, it is possible to bring the trains around curves in the rear of the platforms, all as shown in "Blue Prints" Nos. 4 and 9 at the end of the "Book on Terminals." (**d**) This can be done by auxiliary cables. By this double system a capacity greater than that claimed for the rejected patent system can be attained. (**e**)

You will ask, why was not this system recommended for adoption by the Terminal Committee. It is the circulation system that we approve of. It is absolutely safe, it gives the greatest possible number of cars per hour and it does away with locomotives.

The answer is its enormous cost, chiefly owing to the great amount of new land required.

Here you have a complete answer to the attacks upon us of exaggeration and falsification. Why should we wish to exaggerate the cost of a system that we would like to adopt? The charge is as absurd as it is scandalous.

We said in the report of April 17: 'In this age of inventions there is no knowing what the next seven years will produce.'

What we had in mind was that the same ingenuity which has enabled trains of five cars to go around curves of 90 ft. radius on the elevated roads, instead of 210 ft. radius, the least previously known, may be trusted in the future to devise methods of modifying our cars, their trucks and wheels, and possibly the curved rails, so as to enable them to run around curves of much less than 90 ft. radius. If this can be done, the way to future enlargement is clear.

Take out the rear switching track and connect the platform tracks by curves of as small radius as possible, which will require comparatively little more land and station space.

Until this can be done, go on and use the system you have approved of and adopted.

For these reasons I shall vote not to reconsider the resolution adopted at our last meeting.

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a. *Extract from Report of the Board of Experts.*

"Of all the plans submitted to our review the *one alone* which seems best to conform to the necessary conditions, is the simple "Circulating System", as represented in its general design by the plan offered by Mr. A. M. WELLINGTON, C. E., in which the *objectionable features of all the others* above referred to are eliminated. We have very carefully studied its adaptability to all conditions of the Bridge railway traffic, with the result of a decided and unanimous conclusion in our minds that the simple circulating system is unquestionably the one which best and most completely fits the conditions presented. * * Doubtless it is proper that we should herein note some of the leading advantages which this system is found to possess. They are (1) safety * * (2) simplicity * * (3) economy * * (4) * (5) * (6) more spacious station and platform areas * * (7) disposition of cars in station * * (8) ground plan of symmetrical shape and proportions * * (9) equally well adapted to working trains of any length up to the maximum provided for * *." [ENG. NEWS, March 17, p. 199].

[The 17 plans and modifications of plans before the Board of Experts were divided by them into 4 classes, 1, Tail-Switching, 2, Head-house, 3, Loop, 4, Circulating. The last two agreed in having an endless or loop track around which trains circulated continuously, but differed in almost every other respect, the "loop" plan having gauntleted rails, eccentric loops wholly on one side of the axis of the bridge and the station "longitudinally planned" on the straight track beyond the curve. Of the 17 plans, 16 were included under the first three classes, and 1 only, that recommended, under class 4. The Board of Experts "reported adversely on all the plans included under classes 1 to 3", for reasons specified at length for each class, and then followed with the recommendation above noted.]

a. *Memoranda of* THOS. C. CLARKE *handed to the Board of Experts to be transmitted with their Report as an unofficial part thereof.*

NEW YORK, Feb. 16, 1888.

I. I agree entirely with the conclusions arrived at by this Board that the circulating system, without frogs and switches is the proper one for adoption.

II. As soon as business requires trains of over four cars each, that it will be necessary to run each train under the sole control of one man, in a grip motor at the head of each train, *all* as described by the Board.

III. I am of the opinion that if the circulating system be used at the New York terminus it should, for the same reasons, be used at the Brooklyn terminus.

IV. I would recommend that the chief engineer be instructed to make careful estimate of the cost of the necessary modifications of the bridge, of the new lands to be acquired and the new buildings necessary to carry out *this* circulating system, at the New York, and also at the Brooklyn end of the bridge.

V. In planning these changes, they should be so arranged that trains from the Brooklyn Elevated railroads may be able to pass over the top of the present trains, and into a second story circle over that of the local passengers in the New York terminus, and an estimate should be made of the cost of strengthening the present trusses and adding floor beams, etc., as well as the cost of the second story, so that passengers from any part of Brooklyn can be carried to the New York terminus without change of cars.

VI. The chief engineer should also be instructed to prepare a statement showing the saving in operation that would accrue from dispensing with switching engines for handling trains in use.

VII. The counsel to the Bridge Trustees should be asked what legislation, if any, is necessary to condemn lands, etc.

As soon as these estimates are prepared the trustees will then be in position to decide whether *this* (italics ours) circulating system shall be carried out.

Yours very truly,
THOS. C. CLARKE.

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b. Mr. WELLINGTON'S original proposition was for "14 car trains (unless, of course, until all are needed)." In accordance with their specific instructions to "increase capacity by every means possible", regardless of cost,* the Board of Experts recommended enlargement of the station to 18 cars, and (by implication) considerable expense for street improvements, not originally contemplated nor necessary to the plans, to make access to the station easier. Notwithstanding this action by the Board of Experts, Mr. WELLINGTON still confined his own description of the plan to 14 car trains in a revised report prepared to be appended to the Experts' report, and sent a proof copy of it to Mr. CLARKE, then in Georgia. The following correspondence took place:

From letter of THOS. C. CLARKE to Mr. A. M. WELLINGTON, dated Jekyll Island, Ga., Feb. 26.

I would venture to suggest that, while your report is of the highest interest to engineers, it would be more readable to the general public if made somewhat more concise.

For example:

I would strike out everything relating to the fourteen car plan as all really included in the larger scheme for eighteen cars, and by so doing you make the paper clearer.

T. C. CLARKE.

From Mr. WELLINGTON'S response to above letter, dated New York, March 3.

I appreciate that the revised report might be better for the public if shorter, but almost every point covered is likely to be brought up in objections, etc., which, if left out, might create misapprehension. I will, however, adopt your suggestion about describing only the larger station. *I feared to appall the public by raising their ideas to eighteen cars all at once.*

Mr. WELLINGTON accordingly struck out all reference to the smaller and cheaper plan, except by a foot-note and a cut, and confined his own description also to the larger plan.

In the report of the Terminal Committee (THOS. C. CLARKE and Prest. JAMES HOWELL) published in our issue of April 21, the 18 car plan was condemned on account of cost and length of train and the plans for 14 cars or less were not alluded to.

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c. The reasons given by the Board of Experts for rejecting this plan were as follows:

"As this system cannot possibly be operated without the employment of a complicated system of switches, frogs, crossings and signalling apparatus, of more than doubtful efficiency, we are satisfied that it contains elements of danger, of a gravity sufficient to preclude its consideration."

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* Essential parts of the first letter of instruction to the Board of Experts;

(Dated about September 9.)

MESSRS. F. K. HAIN, JULIUS W. ADAMS and JOSEPH CRAWFORD, Board of Experts New York and Brooklyn Bridge:

We have called you together to submit to you certain changes in the present mode of working trains on the Brooklyn Bridge suggested by C. E. EMERY.

We have to ask you, as experts, to advise which of three systems you would recommend for adoption:

First—Present system increased, if practicable, to six car trains.

Second—Alternating system for six car trains.

Third—Continuous system for six car trains.

In answering these questions we wish you to be bound by the following considerations:

The capacity of the bridge must be increased by every means possible, as the increase of traffic outruns the facilities.

The question of cost, although important, must be held subsidiary to the above two mentioned, as the cost of increasing the capacity of traffic by a new bridge would be incomparably greater than the cost of the above systems.

JAMES HOWELL, President.
THOMAS C. CLARKE.

Essential parts of second letter of instructions:

BROOKLYN, Nov. 12, 1887.

MESSRS. JULIUS W. ADAMS, JOSEPH CRAWFORD, WALTER KATTE, Board of Experts New York and Brooklyn Bridge:

We have called you together to ask your opinion as to the best method of increasing the number and size of trains upon the bridge by such changes in the New York terminus as will allow of the same.

Mr. C. C. MARTIN, chief engineer and superintendent, will present such changes as he would recommend.

Mr. C. E. EMERY, civil engineer, will present plans and reports which he has prepared, advising certain modifications.

But it is our desire not to limit your judgment in any way and to ask you to report to us what you consider absolutely the best method of increasing facilities, consistent with perfect safety, and we would like to be advised what safety appliances are necessary in connection with the system you recommend.

We are respectfully,
JAMES HOWELL, }
THOMAS C. CLARKE, } Trustees.

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d. These plans were among those of the so called "loop type" submitted to the Board of Experts, and condemned by them collectively in the following terms:

III. The "Loop" system is objectionable

First, because it requires the use of dangerous switches and frogs.

Second, it is limited in extent to trains of six or seven cars' length at utmost.

Third, it has the same objection noted in regard to system I., and common to any arrangement of station planned longitudinally east and west.

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e. The tables claiming to show this capacity were before the Board of Experts, and were rejected as not defensible.

The following correspondence preceded the publication of the original criticism in this journal (June 4, 11, 1887) of the adoption by the same Terminal Committee of the EMERY plans, and may be of interest in this connection as showing that this journal took every care to do no shadow of injustice to any one:

JUNE 2, 1887.

MY DEAR MR. CLARKE:—I send you herewith the inclosed proof of an editorial to appear in our Saturday issue, which I beg you will read with care and also hand to Mr. MACDONALD. If it contains anything erroneous or unjust, we want to correct it. I send an independent proof to Mr. EMERY and Mr. MARTIN. I know nothing of the inside history of that plan nor how much it may be purely Mr. EMERY'S and how much Mr. MACDONALD'S or your own, but it appears to me to contain very dangerous and objectionable features, even if there were not another far better plan, as I think there is.

Perhaps I have not understood the reasons for adopting only one man's plan in so very grave a matter without previous discussion or investigation, in any public way at least, and thus may have spoken somewhat differently in the first few sentences than I otherwise should have done; but for the most part the discussion is purely technical.

Yours truly, A. M. WELLINGTON.

In these articles a bare outline of what has since become known as the circulating system was given, with a statement that it offered more possibilities than any other.

JUNE 2, 1887.

MY DEAR EMERY:—I trust the above words will not seem a mockery in connection with the inclosed proofs, in which I have meant to be strictly fair. If I have not, corrections can be made up to 10:30 to-morrow morning, and we can if you desire put in a letter or other matter from you in the same issue. Remember, that if we are wrong in this matter we shall be put to shame. If right, what we say ought to be said.

I dimly felt that your plan was not a good or safe one from the first. As I studied it I liked it less than ever, but I have been and am extremely anxious to be fair, and, of course, want to correct errors for my own sake. If we have been either wrong or unfair, therefore, please promptly advise us and believe me as ever,

Yours sincerely, A. M. WELLINGTON.

Portion of letter from T. C. CLARKE to A. M. WELLINGTON, received June 7, 1887:

* * * If you can show us a way to run continuous trains around a circle without involving the necessity of buying more property, I, for one, shall be very glad to give it the most careful consideration.

Faithfully yours, T. C. CLARKE.
JUNE 6, 1887.

Answered as follows:

In regard to running continuous trains, I cannot of course, show a plan "without the necessity of buying some more property", but I think I can show that it can be done by buying much less land than is commonly supposed, as well as with more ease and with more and greater collateral advantages. In fact I am entirely confident that if the matter could be properly brought before the Board of Trustees, or even your present committee, who are in a measure committed to another plan, they would at once conclude that was the proper plan to adopt. I trust I shall be regarded as entitled to the presumption that I am not making such statement recklessly, but you will at once perceive that to go further in the matter raises a rather delicate question of professional ethics, and we have concluded that it will not be becoming either in us as a paper or in me as an individual to elaborate what we claim to be expert opinions unasked and in a measure force them on the attention of the public when they directly conflict with the adopted plan of another engineer. So far we have not done so except to make a vague suggestion that another plan would be better. Our objections to Mr. EMERY'S plan were positive, viz., that it was inadmissibly dangerous and did not, in fact, increase the capacity of the bridge beyond what was otherwise possible.

I will only add further that I should be most happy at any time to explain to you individually, and not as a trustee, the reasons why I think a properly devised continuous circulation plan the only one proper to adopt under the circumstances, should you so desire, either at this office or your own; but I have no desire to force anything upon the attention of the trustees if they are content with the present status.

This letter was never answered by Mr. CLARKE.

From June till late October no communications were received by Mr. WELLINGTON from the Bridge Trustees. To obtain, if possible, some definite information as to the real purposes of the Terminal Committee, the following letter was written by Mr. WELLINGTON to Mr. HOWELL.

September 23, 1887

DEAR SIR:—I beg to inquire of you, as President of Trustees and of the Committee on Terminal Facilities, if that committee has as yet prepared a report for the consideration of the Board of Experts, recently appointed. I also wish to inquire whether the instructions of the Board of Experts are to consider generally what plans are most expedient for increasing the traffic facilities of the bridge, or whether they are restricted to a choice between specific plans submitted to them.

Yours truly, A. M. WELLINGTON.

This inquiry also was not answered.

The following correspondence preceded by but a few days the appearance of the Terminal Committee's report:

Mr. CLARKE to Mr. WELLINGTON:

MARIETTA, Ga., March 7.

MY DEAR Mr. WELLINGTON:—I have received yours of March 3. I wrote to Mr. HOWELL last week that I hoped he would have the Experts' and your report printed and laid before trustees 10th of March, that they might have ample time to consider same before receiving report of Terminal Committee, which I cannot make until I have the estimates of the cost of the new plan and of saving of expense of operation from MARTIN, which is now being made, as I am advised.

The following letter from Mr. CLARKE closes the correspondence:

JEKYLL ISL., BRUNSWICK, GA., March 20.

MY DEAR Mr. WELLINGTON—I am in receipt of copy of Experts' report from you. As soon as the estimated cost of same is made up we shall make a report on it. I should like to have it attached to the end of the article which appeared in the ENGINEERING NEWS March 17 upon the future extension of New York. As it has been decided to attach your colored map I think the article, which is a most interesting and instructive one and is explanatory of the map, should be attached also; otherwise the full force of the map might not be understood.

Yours truly,

T. C. CLARKE.

Mr. WELLINGTON sent in response to this an informal personal note, referring especially to the fact that the great operating economies which would result from his system were hardly yet appreciated, and inclosing a statement showing that every passenger could be furnished with a seat up to three times the present traffic at a cost of only 1 mill per extra seat. To this letter Mr. CLARKE made no response. The next action was at the trustees' meeting of April 17, when the report of the Terminal Committee (T. C. CLARKE and JAMES HOWELL) was presented, which appeared in our issue of April 21.

On April 19 Mr. WELLINGTON addressed a protest to President HOWELL, published with the Committee report in this journal.

A test of the Enos electric railway at South St. Paul Minn., was made May 9, and the results are reported to have been satisfactory. There are two longitudinal trusses forming an elevated track, from which the cars are hung, the floors of the cars being at the same height from the street as those of ordinary street cars. The trucks from which the cars are hung have wheels bearing on the top and bottom chords of the overhead trusses.

The Weather of the United States for the Month of April, 1888.

[As respects the elements of most interest to engineers.]

According to special returns from the Chief Signal Officer of the U. S. Army.

STATION.	Temperature. Degrees Fah.				Wind Velocity. Miles per hour.			Precipitation. Rain and melted snow. Inches.		
	Average	Max.	Min.	Range.	Average	Max.	Direction. Max.	Total.	Heaviest in 24 hours.	No. rain days.
NORTHERN CITIES.										
Northfield, Vt	35.0	44.7	26.3	18.4	8.8	42	SW	2.87	0.80	16
Portland, Me	39.2	64.5	15.5	49.0	7.0	32	E	3.80	1.85	11
New York City	47.9	84.2	29.2	55.0	11.5	52	SE	3.57	1.35	11
Pittsburg, Pa	50.5	86.0	25.5	60.5	7.3	36	W & SW	1.04	0.23	14
Chicago, Ill	45.4	83.0	30.0	53.0	12.7	37	SW	2.13	0.90	10
Omaha, Neb	52.5	86.5	28.0	58.5	10.4	36	N	2.95	1.10	8
St. Paul, Minn	40.5	76.0	22.6	53.4	7.9	40	E	5.14	1.58	11
Duluth, Minn	35.0	66.8	17.5	49.3	8.4	29	NE	1.57	0.88	9
Bismarck, Dak	42.2	81.2	6.1	75.1	12.6	48	S & NW	0.11	0.04	5
Average	43.1	74.8	22.3	52.5	9.6	39.2		2.62	0.97	11
SOUTHERN CITIES.										
Washington City	52.9	89.0	31.8	57.2	7.2	33	NW	1.89	0.80	11
Louisville, Ky	59.6	84.8	32.5	52.3	6.8	32	W	2.99	1.70	7
St. Louis, Mo	58.7	87.5	34.8	52.7	12.6	44	S	1.88	1.33	4
Savannah, Ga	66.6	88.1	47.8	40.3	8.5	28	E	0.71	0.32	6
Leavenworth, Kan	56.5	87.4	29.5	57.9	8.4	30	SE	2.32	1.02	8
Jacksonville, Fla	70.1	88.0	49.0	39.0	6.8	28	S & NE	0.93	0.88	5
Chattanooga, Tenn	63.6	83.7	40.0	41.7	7.1	26	SW	4.43	1.40	7
New Orleans, La	69.9	85.0	56.3	28.7	7.0	26	N	1.87	0.58	8
Memphis, Tenn	65.5	86.5	43.0	43.5	7.4	32	NW	1.15	0.65	6
Palestine, Tex	68.5	84.4	41.9	42.5	9.2	36	SE	5.62	4.59	9
Average	63.2	86.4	40.6	45.8	8.1	31.3		2.49	1.23	7
WESTERN CITIES.										
Helena, Mont	49.0	78.0	28.0	50.0	8.0	30	SW	0.56	0.20	7
Port Angeles, W. T	46.1	61.3	29.6	31.7	4.7	30	W	1.56	0.56	13
San Francisco, Cal	55.2	87.7	46.0	41.7	9.8	36	W	0.11	0.11	2
Salt Lake City, U	55.5	80.1	31.1	49.0	5.8	30	S	0.99	0.62	5
Denver, Col	53.2	80.6	30.0	50.6	8.0	40	SW	1.71	1.07	6
Yuma, Ariz	75.3	101.7	47.0	54.7	6.5	40	W	T	T	0
Santa Fé, N. M	49.9	72.5	29.0	43.5	6.0	26	E	1.42	0.43	12
Average	55.0	80.3	34.4	45.9	7.0	33.1		0.91	0.43	6

The Contract for the Panama Canal Locks.

The precise terms of the contract made between M. EIFFEL and the Panama Canal Co., Dec. 10, 1887, for the construction of the new locks for the canal have recently been made public, and are of a most extraordinary nature, amounting to the relief of M. EIFFEL from all pecuniary risk, yet leaving him a practical certainty of enormous profit. The terms may be summarized thus:

M. EIFFEL engages to finish the locks, the number of which is expected to be ten, by June 30, 1890, under a penalty of $20,000 for each month's delay. The company reserves the right to postpone its decision as to the number of locks until April 1, 1889, but in that case an extension of time will be granted for their completion. M. EIFFEL agrees to conform to such modifications as the company may see fit to make during construction, and if at any time the company's delegate thinks that sufficient progress is not being made, he shall notify M. EIFFEL, and if in one month steps are not taken to expedite the work, the company may cancel the contract. Notwithstanding this remarkable stipulation, further inspection of the contract shows that M. EIFFEL is in no alarming danger of suffering loss thereby.

The estimated cost of building a lock of 36 ft. lift is $2,101,300, and of 26 ft. lift is $1,859,900, but these estimates are not binding, as the work is to be paid for by measurements made monthly. A good many "allowances" are made M. EIFFEL: $600,000 for special machinery and tools for each of the first four locks, $2,400,000 in all; for transportation of machinery for the four locks, $1,200,000; for renewals for four additional locks, $1,200,000; for plant for control of water courses, $200,000; for coffer dams, etc., $240,000; railways and roads, $600,000; for materials for excavation, $160,000 may be spent, and $200,000 will be allowed, the 20 per cent. being a commission on the purchases. The total of these allowances is $6,040,000, all except $1,200,000 of which is to prepare for work on the first four locks.

The company is to make the following advances on supplies purchased: 30 per cent. on machinery for manipulating the locks; 40 per cent. on woodwork when completed in France, and 20 per cent. more on landing at the Isthmus, 20 per cent. on iron work when ordered, 20 per cent. during manufacture, 20 per cent. on shipments, and 10 per cent on landing; 50 per cent. on cement on shipment, 25 per cent. on landing, and 10 per cent. on delivery at the works. Transportation from Europe to the line of the canal is allowed for at 40 per cent. of the cost of the articles in Europe—one of the most extraordinarily loose provisions in the whole contract.

The company furnishes to M. EIFFEL whatever machines and material he may demand, from its supplies on the Isthmus, free of cost, and all houses, barracks, storehouses, and constructions of every kind necessary to the work. The list of this material and installation includes wagons, railways, switches, etc.; 13,000 ft. of standard railway, with ties, switches, etc.; 50 cars and 5 locomotives; 20 barracks for laborers, 5 houses, and 1 store-house; steam pumps, tanks, reservoirs, boilers, and hose. All these are to be delivered Jan. 1, 1888, and such materials and supplies as the company has not on hand it may buy itself, or authorize M. EIFFEL to buy at its expense, with 20 per cent. added for superintendence and general expenses.

Of the advances enumerated, $200,000 are in cash on the assumption of the work, with large payments following from month to month, while payments for work done are due as soon as the estimate is prepared.

M. EIFFEL is to give security to the amount of $200,000, $40,000 in cash, the balance in non-negotiable notes signed by himself.

The contract is so obscured by details of work that may or may not be done, that it is scarcely possible to judge of its financial results as a whole. But if ten locks be constructed at exactly the figures of the estimate the payments to M. EIFFEL alone, including allowances, will be about $30,000,000. The character of the contract indicates that the company knew very little about the amount of money required, but were willing to foot all bills and take all risks and pay a fabulous sum besides, for the use of M. EIFFEL'S name to aid in raising money.

M. EIFFEL will have no part in any of the canal work except the preparation for and construction of the locks. The other contractors continue the dredging and excavation as heretofore, except for such modifications as the new project necessitates. The completion of the canal does not, therefore, depend upon M. EIFFEL any more than upon any other of the contractors.

A BILL has passed Congress throwing open to settlers the Blackfoot Indian Reservation in Montana, containing 31,000 square miles of rolling prairie and valley lands, the most of which is very valuable for mining and agricultural pursuits.

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D. McN. STAUFFER. A. M. WELLINGTON.
EDITORS.

GEO. H. FROST. - - - BUSINESS MANAGER.

Subscription. — UNITED STATES AND CANADA, $5.00 *per Year;* $2.50 *for Six Months;* $1.50 *for Three Months; Single Copies,* 12 *cents.* FOREIGN COUNTRIES, $6.56 *per Year, or* 3 *cents per number additional.*

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Engineers' Club of Philadelphia, Pa.—Regular meeting, May 19. Secy., Howard Murphy, 1122 Girard St.

Missouri Association of Surveyors and Civil Engineers.—Annual Meeting at Columbia, Mo., beginning May 31. Secy., T. J. Lowry, Columbia.

Engineers' Club of Kansas City, Mo.—Regular meeting, June 4. Secy., Kenneth Allen, 19 Board of Trade Building.

Civil Engineers' Society of St. Paul, Minn.—Regular monthly meeting, June 4. Secy., Geo. L. Wilson, City Hall.

American Society of Civil Engineers, New York.—Regular meeting, June 6. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Regular meeting, June 6. "Temporary Low Service Pumping Plant at St. Louis," M. L. Holman. Secy., W. H. Bryan, 709 Market St.

Master Car Builders' Association.—Next convention at Alexandria Bay, N. Y; commencing June 13. Secy., M. N. Forney, 45 Broadway, New York City.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy. Angus Sinclair, Chicago.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, June 19. Secy., S. M. Wickersham, Penn Building.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, June 20. "Small Pipe Sewers." Secy., S. E. Tinkham, City Hall.

Ohio Institute of Mining Engineers.—Summer meeting at Logan, O., July 11, 12, 13. Pres., W. H. Jennings, Columbus; Secy. R. S. Weitzel, Kittanining.

Roadmasters' Association of America.—Next meeting at Washington, D. C., Sept. 11. Secy., H. W. Reid, Waycross, Ga.

THE extraordinary contract for the Panama Canal locks, which we summarize elsewhere, is surely one of the loosest in the history of engineering. M. EIFFEL is an engineer of prominence in France, who has lately become especially prominent as the designer of the great 1000 ft. tower for the coming Exposition, and his name has undoubtedly helped to give confidence in the successful completion of the work. His "contract", so far as can be judged from its terms, amounts to nothing more nor less than giving him all the money needed for executing his work as fast as it can by any possibility be needed, and a little faster; so that he can at any time abandon the work, if he chooses, with a cash profit in hand. The security that he will not do so appears to be (1) his standing as an engineer, which is high, and (2) that he can make much more money by holding on to the end. Nothing illustrates the loose nature of the contract better than that the allowance for transportation to the Isthmus is 40 per cent. of the cost of material in France. We find it difficult to believe that there is not some error in the abstracts of this part of the contract, and we have not had the full contract before us, if indeed it has been published, but the statements are so specific and so unqualified that we feel forced to the conclusion that they are correct.

In the meantime the great problem of controlling the Chagres drags along with practically nothing done toward solving it. It is a far less serious problem for the lock canal than for the sea-level project, but it must be done for either, and it certainly does not yet appear that it can and will be done without enormous loss of time and money. We speak from no unfriendly feeling toward the enterprise, and are inclined to believe, as we have said before, that the lock canal will finally be pushed through to completion, but the history of the enterprise to date is certainly not calculated to improve the reputation of the French people as administrators of great public works.

THE report of the Massachusetts Railroad Commission on the Bradford disaster on Jan. 10 last, which we were unable to find room for in our last week's issue, gives the facts of the disaster almost precisely as we gave them in our two issues following that event, and therefore, as respects this part of it, does not need reproduction. It will be remembered that there were inside guard-rails brought to a point but not closely connected at the point, and, as the report notes, "the west wheels of the rear truck [of the smoking car] either passed through the unprotected gap between the guard-rails or passed on the wrong side of the point" the latter we think almost certainly, "so that the car advanced toward the bridge, its rear end being twisted much farther out of line than the front end", and hence hit the end-post of the bridge. The Commission justly note that "had the guard-rails been extended along the curve", and been extended far enough, we may add, "or had even a single rail midway between the rails proper been extended around the curve", the trucks would probably have been brought into line, but the clearer and more direct moral seems to be that outside guard-rails to supplement the inner ones would have accomplished the same end more directly, simply and surely, even in this particular case, with still greater certainty of covering all cases. In fact, but for the existence of the "solid wooden fence" to serve as an impromptu outside guard-rail, the probabilities are strong that the smoker would have wrecked the bridge and gone into the river, with heavy loss of life, instead of merely caroming on the end post and tilting over safely within the bridge, thanks to the automatic brakes. The fact that the derailment was at the switch and not the frog, and directly caused by the fact that it was a stub switch *slightly* out of place, we take to be much more clearly established than the Commission's report implies. The engravings of the switch-rails published in our issue of Jan. 14, seem to make this a practical certainty.

THE daily papers have been full of news regarding the Atchison, Topeka & Santa Fe corporation for the past fortnight. It was first reported with full details that the company had bought the whole St. Louis & San Francisco system, a statement without the shadow of a foundation in fact. Hardly were the denials which followed it all published, when a far more astonishing item was telegraphed from Chicago to the effect that the Atchison and the New York, Lake Erie & Western were on the eve of a consolidation. From the wide circulation and the extended space which this item received it would seem that the ideas of newspaper editors on railway control and management must be of a very elementary sort. It seems to be thought that it is as simple a matter to dispose of a railroad system of two or three thousand miles and whose owners are scattered over two continents, as of a single piece of property held in private hands; and as easy to consolidate two vast systems working under entirely dissimilar conditions in different parts of the country, as it is to add new lines in the same regions to existing systems. It is needless to say that the Erie and Atchison officials emphatically denied the absurd story *in toto.* Consolidation is doubtless to go on in the future even more than in the past; but the deals of real importance will not be made between two days nor will their details be arranged "by telegraph, from an obscure hotel, under an assumed name," as was claimed in the present instance. Nor is it at all likely that any of the great systems east or west of Chicago will attempt to extend the domain under one management across the continent, for a long time to come, if ever.

AMONG the important possible applications of the new electric welding process which are beginning to attract attention, that of welding together the ends of rails in place so as to make in effect continuous rails of 1,000 or 1,500 ft. in length is certainly worthy of thought. The process seems capable of this application and the saving, of course, would be not only nor chiefly in the first cost of the joints, but in the extra labor and wear and tear due to them, which is a vastly greater item. Much remains to be determined as to the practicability and cost of getting a really good and reliable weld so as to make the rail continuous, but assuming that to be done—and the indications are that it can be done—the problem stands thus:

Expansion and contraction from temperature is the great evil to provided for, and it would require a special joint every 1,000 or 1,500 ft. Iron or steel expands about .01 ft. in 100, or 1 in 10,000, for every 15° Fahr. of temperature. A rail about 1,500 ft. long would expand about 0.1 ft. for each 10° of temperature. The extreme range at any one place in any one month in our climate, as will be seen from the weather table which appears in this issue and at about monthly intervals, is 50° or 60° Fahr., so that the gap at the rail-ends would change 6 or 7 ins. in one month. There are many places on this and all other continents where the yearly range is little more than this. The means of winter and summer, even in interior North America, rarely exceed 40° or 50° more, or say 100° to 120° total yearly range, so that the gap at the rail ends would fluctuate between zero and 10 to 12 ins. throughout the year, the maximum being reducible one-half or more by a quarterly adjustment.

By planing off the outer part of the head somewhat, and carrying the wheels over the gap with an exterior supporting rail, adding short guard-rails on the inside to keep the flanges from causing trouble, it is probable that such a gap could be passed safely enough. The slipping of the rail back and forth on the ties from expansion would have objectionable elements, but the gain from dispensing with joints would be so great as to far more than balance it. There remains therefore a clear field for any one to show if he can that such welding of rails in place is practically possible.

In certain very even climates, like that of Mexico, where the total yearly range is only 40° or 50°, it is not by any means impossible that strictly continuous rails might come in vogue, assuming such a process, the temperature changes being taken up by internal strain. Compression would never do, or the rails might buckle, but assuming the internal strain to be zero at the maximum temperature the internal tension need not be very great to cover the minimum temperature. Taking the modulus of elasticity at 30,090,000, each 1000 lbs. per sq. in. of strain represents $\frac{1}{30000}$ extension, which is that due to 5° less heat. Consequently, each 1° Fahr. would throw a tensile strain of 200 lbs. per sq. in. on the rail and 50° would throw 10,000 lbs. per sq. in. upon it. Up to this maximum, it would probably be found by experiment, the strain could be provided for by a very moderate increase of section without decreasing the transverse strength.

The mere friction on the ties of a rail 1,500 ft. long would throw a strain of 1,000 lbs. per sq. in. on the rail at the center in order to move it, assuming a coefficient of friction of 0.4 as will readily be found by computation; and this may at first sight seem to introduce danger of buckling, but such is not the case if the line and grade be anywhere nearly straight to begin with. On curves, of course, much shorter sections would be necessary. The sole necessity for introducing an improvement of this kind, therefore, is evidence of a practically feasible method of effectually welding the rails. We have no doubt whatever that trackmen will seize on it with avidity when produced, especially if accompanied by a ready method of "unwelding." The joints are the most costly and the most hopeless element of track. Once eliminated, it is hard to say to what perfection maintenance of way might not be brought; certainly it would be far greater than now.

INTERESTING advertisements from *Indian Engineering*, the rupee of 45 cts., silver being translated into its gold value of some 36 cts. are the following:

Madras Municipality wants a sanitary inspector, salary $36 per month.

Engineer wanted for the Tyzabad municipality, salary from $27 to $43.20.

Two native surveyors and levelers wanted, salary $12.60 and $2.60 horse allowance per month. "Apply with copies of certificates to District Engineer, Durbhunga.

Two deputy "over-men" with coal-mining qualifications on the North-Western Railway wanted. Salary $39.60 to $43.20 "per mensem".

Head draftsman wanted forthe Office of the Agent and Chief Engineer of the Bengal-Nagpur Railway, on a salary of $72 a month. Applicant must be experienced in drawing and in the management of a drawing office.

These, be it noted, are all advertisements for the services of Englishmen who have expatriated themselves for the sake of bettering their condition and who have a certain amount of technical skill, with the sole exception of the "native surveyors and levelers" who are to luxuriate on $12.60 per month with $2.60 horse allowance. We have no doubt that there are better plums than these, but they do not appear in the advertisements, the above being all that appear. On the whole, the tendency of the above should be to make the discontented tolerably content with their lot in this country. That the unfortunate "nature surveyors and levelers" should have to take out a "certificate" that they are worth $12.60 a month before they can earn it, strikes us as rather hard.

From causes beyond our control there has been considerable delay in the mailing of ENGINEERING NEWS for three weeks past.

Probably 90 per cent. of all the weekly papers published in the large cities are "manufactured" under contract with large and completely equipped printing offices. This journal, like the *Railroad Gazette*, *Engineering & Mining Journal*, *the Electrical World*, and half a hundred others, is printed, addressed and mailed by the *N. Y. Independent*, which journal is one of only three or four in the city running day and night with double sets of employés. ENGINEERING NEWS is usually run off Friday afternoon from six presses, and is preceded or followed according to contract by other journals. Now, the *Independent's* press rooms were removed from Rose St. to Gold St., May 1. To do this and keep their customers, one half the number of presses had to be taken down and removed in advance and the usual work done on the remaining presses until all could be started up again. An ordinary removal is enough for an ordinary person, but when one of the largest press rooms in America, together with the appliances for handling half a million or more of newspapers of all sizes and shapes, is to be changed from one location to another, it may well be conceived that somebody must suffer. The delays in printing were unavoidable, but we are assured that with this present issue everything will be running with better service than heretofore. Of course, we have felt the serious nature of the delays, and the printers have been driven nearly distracted with complaints from irate publishers. But with an improved service henceforth we hope that this annoying episode of "moving day" will soon be forgotten.

A New Railway Line for Atlanta.

The railway system known as the Seaboard Air Line includes the Seaboard & Roanoke, Carolina Central, Raleigh & Gaston and Raleigh & Augusta Air Line railways, and extends from Portsmouth, Va., to Raleigh, Wilmington and Charlotte, in North Carolina. It is now known that the managers of this system have plans whose execution is well advanced, which will make their lines a much more important factor in the through traffic between Northern markets and the trade centers of Georgia and Alabama. The Georgia, Carolina & Northern Railroad Company was chartered early in 1887 with Gen. R. F. HOKE of Raleigh, N. C., as President, and surveys were at once put in progress under Chief Engineer J. S. MORRISON, of Athens, Ga., for a line of railway from Monroe, N. C., a point on the Carolina Central, 160 miles west of Wilmington and 324 miles from Portsmouth, Va., to Atlanta, Ga., a distance of 267 miles. The grading on about 50 miles of the road from Monroe to Chester, S. C., was completed last season and several additional sections are now under contract. Tracklaying is in progress between Monroe and Chester, and this section of the line will probably be opened for business at an early date.

The company is now marketing through Messrs. John K. Gilliat & Co., of London a bond issue of $2,691,000. These securities bear 5 per cent. interest, are due in 1929, and the payment of the interest is guaranteed by the Seaboard & Roanoke Railroad Company, until the whole line from Monroe to Atlanta shall be in operation. The distance from Atlanta to Portsmouth by this route will be about 591 miles. At this point connection is made with the ships of the Baltimore Steam Packet Co., and the Old Dominion Steamship Co., for Northern cities; or an all rail connection may be had *via* the Petersburgh Railroad to Richmond, Va., making the distance from Atlanta to Richmond 595 miles against 549 miles *via* the Richmond & Danville. A ferry connection is also in operation to Cape Charles, Md., the terminus of the New York, Philadelphia & Norfolk Railway. The distance from Atlanta to Philadelphia by this route would be 847 miles against 780 miles by the Richmond & Danville. It is but fair to say, however, that the Seaboard & Roanoke company can shorten their line considerably by building some cut-offs, and are likely to do so. The difference in distance, also, is not so great but that the company can compete very effectively for through passenger traffic with the Richmond & Danville, which up to the present time has been practically the only outlet from Atlanta to Northern export points. Rumors have been in circulation that the Richmond & Danville, East Tennessee, Virginia & Georgia, Georgia Central, and other companies were to combine in an attempt to defeat this new competing line; and that they will, if necessary, build a road to closely parallel the Georgia, Carolina & Northern. It is altogether probable, however, that this is at most a game of bluff which will amount to nothing.

By the construction of this extension the Seaboard & Roanoke system will gain not only an entrance to Atlanta, now acknowledged to be the chief railroad center of the South, but will cross nearly at right angles ten different lines of railway and pass through Chester and Abbeville in South Carolina, and Elberton and Athens in Georgia. The line parallels the Atlanta & Charlotte division of the Richmond & Danville system on the north and the Georgia Railroad on the south, but at a distance of from 30 to 60 miles from either, hence the local east and west traffic from the rich farming country through which the line runs will doubtless be very considerable. A clear idea of the situation as outlined above may be gained by reference to our map showing railway building in the South, published Dec. 3, 1887.

The stock of the Seaboard & Roanoke Company is principally held in Baltimore and Philadelphia; and the management, headed by Mr. JOHN M. ROBINSON, has long maintained a reputation for conservative and honest control of the properties entrusted to it. Evidence of which is given by the fact that during the past seven years, out of a total of gross earnings of about $4,415,000 about $714,000 has been paid in stock dividends.

The Past and Future of New York.

IV.

CONCLUSION.

We saw last week that the total population of the whole metropolitan area was likely to be *in thousands*, the figures for 1890 being actual and for 1890 certainly somewhat too small):

1880	1830	1900	1910	1920	1390
2,583	3,358	4,366	5,676	7,378	9,592

And the maximum probable population of Manhattan Island:

1,165	1,400	1,600	1,833	1,833	1,833

Leaving for Brooklyn, Jersey, Westchester Co., etc.:

1,418	1,958	2,766	3,843	5,545	7,759

This was allowing only 30 per cent. increase per decade for the next 5 decades, against 48.2 per cent. in the past 6 decades, or a rate somewhat less than the average growth of the entire population of the United States for the past century (32.7 per cent.) instead of a very much greater one. For reasons heretofore summarized there can be little doubt that this is a minimum estimate for the period preceding 1920. After that date there is a larger element of uncertainty, but as the population of the whole country by 1930 is likely to be (Table VII, April 28) nearly 180,000,000 against 50,000,000 in 1880, it cannot be long after that

date, at least, when the figures given for the metropolitan population will be attained.

It remains to be seen how the very large future population exterior to Manhattan Island is likely to be distributed, and this part of the problem is enveloped with such uncertainty that it would be quite hopeless to attempt even approximate precision, the main purpose being to bring out how greatly the *distribution* of this aggregate growth will depend on the measures taken to bring the available areas within easy access of New York proper.

Abstracting a few of the most significant figures only from Tables I and III (ENG. NEWS, May 5) we have the following synopsis of the past for the four chief subdivisions:

Section.	Population. 1 = 1,000			Per cent. Decennial Growth.		
	1880	1860	Inc	1870-80	1860-70	1820-80
New Jersey,	539	240	299	37.8	63.0	49.2
Westchester Co.	150	99	51	14.7	32.0	29.0
L ng Island,	690	337	353	39.9	46.7	66.2
Staten Island	39	25	14	18.1	29.6	45.9
Total.	1,418	701	717	——	——	——
Manhattan Island,	1,165	814	351	23.3	15.8	45.3

It will be seen at once that Westchester Co. (in which we have included the "annexed district" of New York) and Staten Island cut a very small figure in the metropolitan developement of New York and one of increasingly slight importance, and the reason is notorious and readily discovered on the little map which was published in our issue of May 5,—their comparative inaccessibility. It will probably be found in 1890 that the Westchester Co. district has improved somewhat, as an effect of the elevated railways, but as it has not heretofore grown as much as two-thirds the rate of the metropolis as a whole, and lately only one-half as fast, it is certainly not likely to grow much more than two-thirds as fast hereafter (i. e. 20 per cent. per decade) unless it is given, not simply equality in transportation facilities with other sections, but a distinct superiority, by the construction of greatly improved rapid transit connections, of which it alone enjoys the advantage. Staten Island is so unimportant a factor now, that whatever rate of growth be assumed it will not become much more important for several decades. Taking the growth of both Westchester Co. and Staten Island at 30 per cent. per decade, we have left the following population to be divided between Long Island and New Jersey.

	1880		1890	1900	1910	1920	1930
Staten Island,	39		51	66	86	111	145
Westchester Co.,	150		195	254	330	429	557
Long Island,	690	1,229	1,712	2,446	3,427	5,005	7,057
New Jersey,	539						
Total, as above,	1,418		1,955	2,766	3,843	5,545	7,759
Manhattan Is'd,	1,165		1,400	1,600	1,833	1,833	1,833

Under any kind of reasonable assumption the proportion of the total population appertaining to Long Island and New Jersey together cannot well be less than the above, nor that of Manhattan Island more, for no event of the future is more certain than that the removal of the insular obstacles to the spread of population which have alone caused such a terrible congestion of population in the poorer wards of New York, will result in relieving that congestion, as it has in London.

As between Long Island and New Jersey, where will this enormous coming population go? It is almost wholly a question of ease of transportion, with the odds decidedly in favor of Long Island. Without a North River bridge with excellent rapid transit connections in New York, the rapid growth of the New Jersey area must soon cease. With it, a mere glance at the map given May 5 will show that there is a great area between the 10 and 20 mile belt, quite as favorably situated as the small corresponding Westchester Co., area for access to the business center, and capable of housing an enormous population in suburban fashion. As it is to the last degree improbable that we shall have to wait more than a decade or so longer for a North River bridge, and perhaps tunnels likewise, Staten Island and Westchester Co. must forever compete with this area on rather unequal terms, irrespective of their smaller area.

On the other hand, only a small fraction of any metropolitan population cares to be housed in suburban fashion, enough to travel any great extra distance therefor, and certainly they will not travel unnecessary distance to be housed in city fashion; and of the area remaining for city growth proper—that within 10 miles of the business center—the only area of much importance remaining is that on Long Island. There is room enough there to house in city fashion 5,000,000 or 6,000,000 more people with perfect ease, as may be seen by referring back to map in our issue of March 17, with its accompanying editorial, without requiring any of them to live more than 10 miles from the business center. It appears to us certain therefore that the larger portion of the above undistributed residue is destined to be housed in Brooklyn and the surrounding area on Long Island, alway assuming that transit across the East River is to be provided in sufficient excellence and abundance to put an end to its limiting effect on population. It is not likely that this will be done as soon or as completely as it should be, but it is likely that it will be done, and probably as fast in proportion as the facilities of access to the other outlying districts are improved.

Notes on European House Building and Streets.

(EDITORIAL CORRESPONDENCE.)

To the American, of the United States at least, the masonry seen in public works and private construction throughout the Continent is a marvel for its thoroughness and massive proportions. In a late letter (ENGINEERING NEWS, May 5,) describing a trip from Paris to Marseilles, some mention was made of the excellence of work of this character found upon that line, and it might be added that good work in stone is the rule rather than the exception on European railways generally.

But the house construction is just as substantial and the infrequency of destructive fires is not to be wondered at when the buildings are examined, new as well as old. In Paris, stores were seen in course of construction that had walls of coursed masonry 2 ft. thick at the third story; with through headers and all well bonded. The floors in the older houses were made of heavy wooden beams, but they were thoroughly filled with plaster between and usually tiled on all floors. The division walls between rooms were also of masonry and not lath and plaster. In the newer houses iron beams are being substituted for the wood, but the filling and fire proof character is preserved by brick arches. Owing to the moisture in the stone and the free use of plaster, it takes some time for a French house to thoroughly dry out, and an old Paris proverb says: "The first year we rent a new house to our enemies; the second year to our friends, and the third year we live in it ourselves"—that is, if we are wise and would avoid damp walls.

Another peculiarity in construction in Paris, and many other French cities, is due more than anything else to the peculiar stone used. This stone is a bright yellow in color and when newly quarried is so soft that it is roughly worked with a saw and axe. In building, therefore, all decorative features are cut after the house is erected; that is, squared, projecting blocks are left, and the moulding, ornamental window and door caps, and in many cases elaborately carved details are all cut out of these rough blocks afterwards. In this way we see sometimes the frame of a panel or a circular moulding completely finished over a century ago, and the central mass yet awaiting the sculptor's chisel that for some reason has been delayed. Exposure to the air makes this stone as hard as good limestone, and the work done in it lasts for centuries.

While the Italians used a harder stone to build with and doubtless did most of their ornamentation on this stone before erection, it is yet very evident in many cases that considerable work was done after erection. This plan of working the material required great manual dexterity and skill, and furnished opportunity for the display of any individual talent in the workmen. As compared with our own methods, where the architect first completes the house on paper, in every detail, it is the difference between making the workmen mere copyists by rule and square and permitting them to use their own judgment in details. That this was a safe method of procedure centuries ago is very evident from the wonderfully rich and varied tracery in stone so often seen on the Continent, in churches and public and private bu ldings. That it would be advisable now, with our very different training, is a question seriously open to doubt.

Next to the buildings of Continental cities the streets would excite interest in the American stranger. We do not here propose to enter into a description of the newer streets, like those of Paris, Brussels, London, Berlin, etc., for that has been often and well done before, but the streets of the older towns excited our interest most. First, in their crookedness and their total disregard for the wishes of the stranger who wishes to reach some definite point by the nearest road. There are some wonderfully short cuts—when you get to know them—but as these usually start up some dark archway or narrow alley it takes time to learn where they are. We attempted a short cut in the old town of Avignon, in the south of France, and finally escaped by blundering out of a gate that led outside the walls of the town, and then carefully following around, outside these walls, until we found another gate that opened on familiar ground. There was a traditional Philadelphian who was made cross-eyed bow-legged and left-handed—and we believe he stuttered also—in trying to go from the Tremont House to the Long Wharf, in Boston, without a guide; what would have been his ultimate fate in Avignon can only be guessed at.

These old streets are not only crooked but they are also very narrow and as a rule destitute of sidewalks. In Genoa and Naples they are paved with stone blocks about 24x10 ins. by 8 ins. thick, laid on diagonal lines meeting in the middle of the way. In these streets the foot passenger seems to have no rights which vehicles of any kind are bound to respect; between cabs and omnibus-like street-cars, that wander at their sweet will over the whole street, untrammelled by rails, donkey-carts, donkeys with huge panniers that almost conceal their little bodies and big bray, between drays and all manner of vehicles recklessly driven, the pedestrian is expected to pick his way and look out for himself. The drivers yell at the stranger most lustily, but as in the Italian towns everybody seems to be yelling, with or without provocation and continuously, the warning does not always reach the party for whom it is intended, and accidents do happen to natives as well as to strangers.

Speaking of street-cars brings us to the form of rail adopted where any rail is used. As far as seen, the grooved rail is in universal use, but there are several types of this rail.

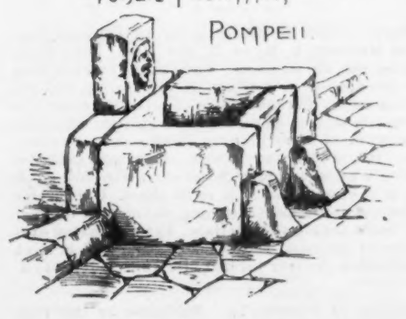
The strongest and best form seems to be made of two low T-rails resting upon a chair and separated by an iron casting that forms the bottom of the slot for the rail. The rail heads are about 1¼ in. wide and the slot is 1⅛ in. wide and about ¾ in. deep. The chair which supports the rails rests upon wooden cross-ties 3 ft. apart, and these ties in turn have a base of 8. ins. of concrete. As the stone pavement is laid level with the heads of the rails and is above the top of the cross-tie, the whole structure is very solid and presents the minimum of obstruction to passing vehicles. In other cases the rail is somewhat like our own side-bearing rail, excepting that the rail head is narrower and the space for the rim of the wheel is deeper and also narrow. This rail is spiked down on a wooden

longitudinal tie as with us. As there is often to be seen, even in Paris, a sinking of the stone-blocks away from the rail, this track is liable to become a nuisance to passing coaches. Even the better form of depressed rail is not entirely an unmixed blessing in winter weather. As far as mud is concerned this is cared for by attendants along the line who run over it with a lipped shovel. But in the past winter, which was unusually severe for Paris, the Passy tramway was compelled to suspend traffic for a short period at several different times, owing to the packing of snow and ice in the groove which made it impossible for the tram car to keep the track. This is the very state of affairs prophesied for this type of rail in New York, and the objectors would seem to have some grounds for their doubts in the Passy experience. It should be added, however, that the Passy rail is of the class last described above and the groove is shallow.

The breaking of streets for pipe-laying and sewer-building may be frequently noted; but not to the extent of our own work in that direction, and here extreme care is exercised in refilling the ditch. Water and patient, hard ramming are the agents chiefly depended upon for consolidating the soil again, and if the absence of depressions in the street surface is any sign, they refill well.

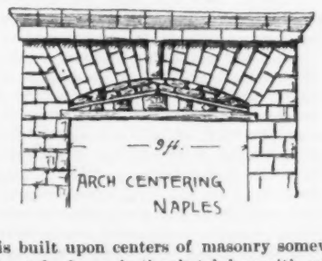
The country roads of Europe are superb as to condition and maintenance, and as far as the traveler has opportunity to see, even a poorly kept road is the rare exception. The surface is macadam, but it is smooth, well crowned and well drained. The only objection to these roads is their dazzling whiteness in the South of France and Upper Italy, from the use of a species of chalk material, and their dust in dry weather. In some places a width of about 8 ft. in the center of the road would be paved with squared stone blocks, as carefully laid and as well maintained as in the streets of a city. In France and Italy these country roads are built and cared for nominally by the commune; but the State grants aid and superintends and controls the construction to such an extent that road-making and maintenance is practically a national rather than a local care. With the short time at command and the difficulty of obtaining official information of the proper character, in a land swarming with officials, it was impossible to learn just how these roads are built and kept in such good condition, even over barren wastes miles in extent. But by the assistance of our friends we trust to obtain further information, in the hope that it may be useful in America, where country roads at least are a reproach, and the methods by which they are supposed to be built and maintained are as wasteful as they are lacking in system and responsibility.

Pompeii was well paved 18 centuries ago with blocks of lava, of irregular form but fairly close joints, and the main streets were provided with good side-walks elevated about 18 ins. above the street



surface. The town was also provided abundantly with water by public fountains at short intervals that were fed by leaden pipes wisely laid under the sidewalk and not in the street as with ourselves. Many of these water pipes are still to be seen in the private houses as well as in the public ways, and the bronze stop-cocks are so much like those now in use that it is difficult to realize that the Roman plumber who set them presented his bill nearly 2,000 years ago. Pompeii had its sewers too; one especially examined was about 5 ft. high and 3 ft. wide, with vertical side walls and arched top, and the bottom had a central semi-ovate groove with side ledges. Within 48 hours after visiting the Pompean sewer we saw workmen in Naples constructing one just like it in general design and almost in dimensions; and it is not such a bad design either; far better in fact than the flat-bottomed semi-circles of brick or the square wooden boxes so much used in the earlier drainage construction of our own country. The Naples sewer, although only about 2½ ft. wide in the clear was laid with side walls of tufa 20 ins. thick and covered by an arch of the same material fully 20 ins. deep; the bottom and the sides were covered with a smooth coat of cement rubbed and fairly polished. It was very slow work, but it was undoubtedly honest and substantial.

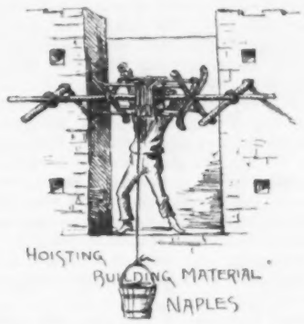
This tufa is the universal building material in Naples, and its lasting character is attested by the fact that the walls of the Castle of St. Elmo, on the heights back of Naples, were built of this stone in 1343, and the ditch surrounding the fortress was dug out of the solid rock; the walls are yet in excellent condition, showing the holes for the scaffolding of the original builders, and the sides of the ditch stand vertical and as smooth as when first excavated. The tufa is quarried mainly by the use of a chisel-like pick with which the rock surface is grooved, and the large blocks are then split off by the feather-and-wedge process; a species of long-bladed axe is used in splitting the larger blocks into what may be called "one-man stone", and these are in turn quite truly squared for wall-building by a broad axe. The stone when first quarried is dark in color owing to the water in it, but this soon dries out and leaves the surface a pleasing yellow in tone. The stone is not strong and would be valueless as a beam; and hence all openings are arched over, either round or flat. The walls of all considerable buildings are of great thickness, as much as 6 ft. in some cases, and the partition walls are also of stone masonry. The houses of tufa are finally finished on the outer surface in stucco, and all ornamental details struck out in the same material. The arch-



work is built upon centers of masonry somewhat after the style shown in the sketch herewith, which is from a house actually being built at the time of our visit. The mortar used with masonry is generally made from the pozzuolana, or hydraulic cement found so abundantly in the immediate neighborhood of Naples at and about Pozzuoli, from whence this cement derives its commercial name.

In connection with the building operations about Naples it is interesting to note the conservative spirit which has preserved and almost daily makes use of appliances which have been tested by the use of centuries, as exemplified in the style of sewer before mentioned and in the accompanying sketch, which shows a method of hoisting building material now in use and which might well be copied from one of the drawings of that engineer artist of the 15th century, LEONARDO DA VINCI.

The fact that the great majority of buildings are thoroughly fire-proof in this country accounts, in a great measure, for the ridiculously inefficient fire departments, not only of Naples and Italian towns, but even of great cities like Paris. Near our hotel in Naples was the headquarters of one of the fire-brigades of the city, and the fire engine, there carefully housed and guarded, could have been loaded on a wheel-barrow It was simply a box to hold water, and a small brass piston pump operated by two brake levers large enough for two men each to work at; the engine would probably throw an inch stream about 100 ft. with about as much force as could be expected from a good garden hose. But whatever there was lacking in the fire apparatus was more than made up by the style of the firemen. The great powers of Europe are nothing if they are not military, so the firemen are gorgeously uniformed, with helmets of brass, and in front of the engine house referred to solemnly paced a fully equipped Italian fireman with a drawn sword. We never had the extreme felicity of seeing one of these brigades at work upon an actual fire, but cannot refrain from picturing their utter woe and helplessness were they to be wickedly brought face to face with an every



day New York fire. On entering the harbor of Naples at night we saw the flame of what appeared to be a fire of some extent in a new part of the city devoted to ship building; but from appearances it was simply allowed to burn until the inflammable material was exhausted. In one sense these cities are happy in their old time ignorance, for they have few serious fires and as little need for modern appliances, thanks to their "old fashioned" methods of solid construction.

PERSONAL.

GEO. HORNUNG, of Cincinnati, O., has been engaged as Consulting Engineer by the Water-Works Trustees of Sidney, O., for the extension of their works, and he is now engaged upon the plans and specifications of the work, comprising a power house with duplicate set of machinery, stand-pipe and a mechanical filtering plant.

GEO. H. SIMPSON, the Democratic Candidate for City Engineer, Terre Haute, Ind., was elected to that office last week.

BENJAMIN BAKER, of the Forth bridge, is now in this country, and on Wednesday last examined the new Poughkeepsie bridge in company with the DUKE of MARLBOROUGH, Gen. GEO. S. FIELDS and T. C. CLARKE, of the Union Bridge Co., and Bridge Engineer THOMPSON, of the New York Central & Hudson River R. R.

MORGAN G. FOOTE, Chief Engineer of the Great Ontario mine, and also of the Doty mine at Park City, Utah, was killed May 7. He was riding on horseback from the mine to the mill, when he was overtaken and thrown down and run over by a runaway team, the road being too narrow for him to turn aside. He was one of the best mining engineers on the Pacific coast.

Pittsburg Engineering Notes

Special Correspondence.

Pittsburg just now is all torn up. Ever since the natural gas companies started to tear up the streets the city has been in a chaotic state of mud and dirt.

The principal cause therefore is the Pittsburg Traction Co., which is laying its cable conduits on Fifth Avenue and is now rapidly approaching the business center. The power houses are nearly complete and the prospect of seeing "horse cars without horses" in operation next winter are considered bright.

Still another cable road is under way, the Citizens, coming down Penn Avenue. Both roads start from the same terminus at East Liberty, but their lines are widely divergent and their profiles would show quite a difference, the Traction having no level track, while the Citizens has about four miles. The roads are respectively six and seven miles long.

Besides the cable lines, two electric roads have been started, one, the Observatory Hill line, being open to regular travel with four miles of line and four cars running with fair regularity. The other line, the St. Clair, is a rather curious piece of engineering. Starting at the corner of South Thirteenth Street, it has about 1000 ft. of underground wire conduit, with no claims to attention, but from this point on it is quite remarkable. A curve of 35 ft. radius, and 90° long, takes it on to an iron bridge with a grade of 13.3 per cent. for 568.5 ft. at its ex

tremity. The bridge is 1200 ft. long and the minimum grade on it is 9 per cent. A central rack made of punched steel boiler-plate is used on these steep grades and the motor is provided with a sprocket wheel so arranged that it can be dropped into gear with the rack. The term motor is used advisedly as the motor is on a dummy separate from the car, the excessive grades requiring a motor too heavy to go on the cars. The Daft system is used on this road, while the Bentley-Knight system is used on the Observatory Hill road. The latter road uses a cast rack at the side of the track with a fixed gear cast on the side of the driving wheels of the cars, to climb its heavy grades.

There is every probability that the Pennsylvania Company will elevate its tracks in Allegheny next year, the recent fatal accident at the Federal Street crossing having increased the probability. The length of the line to be changed is about two miles and the estimated cost about $1,300,000, including the changing of the Allegheny river bridge and the approaches to the Union station in this city.

Rail consumers will be glad to know that the Edgar Thompson works are again running in all departments.

Allegheny is going to have pure water, and according to the surveys just completed, it is going to take nine miles of 60-in. steel pipe to reach a suitable point on the Allegheny river to draw the supply from.

The Central Expanded Metal Co. is the name of a new concern, with works at Rankin, for the manufacture of lathing, fencing and window guards, made by cutting thin steel or sheet brass and drawing it out so as to form diamond shaped meshes, in the same way that children make a belt out of a small visiting card.

The Standard Underground Cable Co. utting down several miles of cable for the Western Union.

The Engineers' Society of Western Pennsylvania has adjourned for the summer. The members are very much interested in the Bessemer steel pipe and tube, now being successfully made at the Riverside works. Few of the papers read during the last year attracted so much attention as the one on this subject by Superintendent BRAY. The samples of pipe at the Society rooms show perfect weld, better threading than is often seen on iron pipe, and bending and flattening tests that would, inevitably, split any iron pipe, all borne without a flaw by the steel pipe. It is, certainly, a good practical proof that Bessemer steel will weld if handled properly. Many members thought that the samples were solid drawn; but they are ordinary butt-weld and lap-weld pipe.

The Etna works, perhaps in rivalry of the Riverside, are making a most excellent line of Siemens-Martin steel pipe which shows its ability to stand any test made with the Bessemer pipe.

The process seems to hold out some promise that it may be possible to get out a welded tire at a much lower price than the present solid rolled style, with as great or greater endurance.

The Hainesworth Bessemer steel gun is still at the Steel Casting Co's. works, awaiting orders from Washington. That so large a casting with such physical properties should have been successfully made, is certainly one of the events of the year. Should the final firing tests be as successful as the tensile and bending tests, many applications heretofore undreamed of may be made of Bessemer castings, and Krupp may have a less undisputed prominence in certain fields.

CORRESPONDENCE.

Mortises in Trestles.

LEADVILLE, Colo., May 5, 1888.

EDITOR ENGINEERING NEWS:

In an article in your issue of April 7, on "Pile and Trestle Bridges," the writer states "he has yet found no satisfactory and economical method for avoiding mortises in the connection of caps and sills with posts. The writer had experience with both the mortise and tenon style, and also with the drif bolt and iron dowel style, and for the ease, cheapness and rapidity with which it can be put up as well as for its solidity, considers the last method by far the preferable one, and as to durability the mortise system gives less bearing surface and more chance for rot as compared to the other.

All the framing needed is to gain the caps and sills about an inch into the posts, using a 6 in. dowel at the bottom and a 22 in. or 24 in. drift bolt at the top. The square gain prevents all turning or twisting while the bolts and dowels together with the sway braces hold everything secure crosswise of the cap and sill.

The writer has put up and seen erected many million feet B. M. of trestle bridging in this style, some structures as high as 125 ft., and has never known a single joint to start or fail in any way, some of this work being now subject to use under the heaviest locomotives ever built.

J. O. BARLOW.

[We agree entirely with the substance of our correspondent's position, and had intended discussing the matter from that point of view, pending which discussion we will now say no more on the subject, although it does not appear to us that our correspondent's letter covers the whole case. ED. ENG. NEWS.]

Beacon Street Improvement.

12 Pearl Street, Boston, Mass., April 23.

EDITOR ENGINEERING NEWS:

It may be of some interest to you to know something of the progress which has been made thus far upon the work, and we therefore give some extracts from our report to the Board of Selectmen, published in the annual town report last February.

The general scheme of the avenue you have already discussed in your columns, [Oct. 22, 1887, p. 292] and we will only recapitulate by saying that the avenue is in Brookline, and is about 2¼ miles long and 160 ft. wide, except in the neighborhood of Corey Hill, where in order to admit of the roadways being on different levels, the width is increased to 190 ft. There are two roadways, 50 ft. and 30 ft. wide respectively, a bridle way 20 ft. wide, four planting spaces each 5 ft. wide, and sidewalks on each side 10 ft. wide. The road is to be macadamized in a thorough manner and the sewers, surface-water drains, water and gas supply systems are to be provided in advance of the finished grading, in order to avoid as far as possible, the tearing up which is so fatal to the macadamized road. During the past season, about 6,000 ft. of brick sewer, varying in size from 48 ins. × 72 ins. down to 20 ins. × 30 ins., and about 7,000 ft. of pipe sewer, 18 ins. to 8 ins. in diameter, have been laid. Of the brick sewer, about 700 ft. were built on piles through a treacherous fresh water bog, having a depth in places of nearly 60 ft. and upon which the filling had, within 2 months or so, been deposited. This part of the work naturally gave no little anxiety as it was impossible to tell in advance how the new filling would act when the trench, 10 ft. wide and 16 ft. deep, was dug. Fortunately the fears expressed by some citizens were not realized, and the work is standing perfectly well, without more distortion than would often be the case in sewers built in hard ground.

In the road department, about 4,000 ft. of the full width, 4,000 ft. more of the broad roadway, and 4,000 more of the narrow roadway were brought nearly to sub-grade. About 3,500 of the narrow road and 2,000 ft. of the broad were made ready for macadamizing, and macadam was laid, though not entirely finished, upon 2,000 ft. of 30 ft. road, and about the same length upon the 50 ft. driveway. To fill the lowland, over 80,000 cu. yds. of gravel and sand were brought by the Boston & Albany Railroad, and in the higher levels nearly 130,000 cu. yds. of earth were excavated. About 8,000 ft. of water pipe were laid and the city of Boston moved and lowered about 1,500 ft. of 48 in. water main. But for unavoidable delays in getting to work last season, much more could have been accomplished. It was April 1, before the town decided to carry out the scheme and to accept the proposal of HENRY M. WHITNEY to construct the road, sewers, etc., at a cost to the town of $200,000, the total estimated cost of the work being $350,000. The arrangement of the details of the agreement with Mr. WHITNEY and the removal of the buildings, etc., took so much time that it was the first of July before work in earnest could be begun, although work on a small scale was commenced early in May. It was well into September before any water pipes were received for the changes, and this caused further delay. The city of Boston was unable to obtain the 48 in. pipe until quite late in the fall, and until the work of laying the new pipe and connecting it with the old had been completed, a very considerable portion of our work on Corey Hill had to be abandoned. This year, however, we are making a good start and have every hope of completing the work this fall. There will in any event be considerable finishing work such as tree planting, etc., to be done next spring, but the road as a road we expect to finish this coming fall, and within the estimates of cost. The cost of the road has thus far been, in round numbers, $119,000; sewers $58,000; water $33,000; total, $209,000. ASPINWALL & LINCOLN.

Chief Engineers.

A Civil Service Conundrum.

EDITOR ENGINEERING NEWS:—

Will you kindly examine the following notes and tell whether there is enough information given to answer the question there propounded.

The extract is from the Civil Service Commissioners' Report and deserves attention. Many applicants have stumbled over it. Are the civil service examiners competent?

Calculate cubic yards excavation and embankment in following sections: (+) = cut. (−) = fill, both written over distance from center. Slopes, 1 to 1. Road bed, 30 ft. wide.

NOTES.

Sta.			Cent.	
0	+ 12 / 27	+ 8.7 / 14	+ 5.9	+ 6.0 / 21
50	+ 16 / 31	+ 6.9 / 10	+ 3.1	0.0 / 15
100	+ 14 / 29	+ 5.3 / 12	0.0	− 4.0 / 19
150	00 / 15	− 5.7 / 8	− 8.1	− 12 / 27

How is the relative amount of excavation or embankment, or the absolute amount, to be determined with these notes. X. Y. Z.

[There is abundant information given for determining precisely the volume of both cut and fill between station 0 and 150, and to any one familiar with the practical routine of railway or canal construction the question should be a very simple one. But it is one which might well puzzle anyone not familiar with that special class of work, and we should judge it would have been no more than reasonable to either plot the sections or instruct the applicant to first do so, that he might thus obtain a hint.—ED. ENG. NEWS.]

PUBLICATIONS RECEIVED.

Practical Hints for Draughtsmen. By CHARLES WILLIAM MACCORD, A. M., &c. D. New York, John Wiley & Sons, 1888, 4to. 100 pages. Price $2.50. This is a book for the student of mechanical engineering and the author claims that the leading object of the treatise is to explain various modes of representation which are in many cases better than the precise ones of projection. It is preëminently a book of common sense descriptive geometry, and the student will find much that is new, and interesting in its pages. One chapter is devoted to free hand sketching, and another to drawing instruments and materials. The mechanical execution of the book is unusually good, and is most creditable to the very popular firm which publishes it.

Sketches of Pineville, Ky. Published by the Pine Mountain Iron & Coal Company, 327 Fifth St., Louisville, Ky., 6 × 7½ ins., 63 pp. 3 maps. This is a neat little pamphlet describing the natural resources of Pineville, Ky., the present terminus of the Cumberland Gap extension of the Louisville & Nashville R. R.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—At the meeting on May 16, Vice-President J. J. R. CROES in the chair, and a large number of members present, Mr. JAMES B. FRANCIS, Past President, read a paper on "High Walls or Dams to resist the Pressure of Water", an abstract of

which we publish elsewhere. Some written discussions were read, and the paper was verbally discussed by Messrs. BRINKERHOFF, FTELEY CHURCH, WEGMANN, COOPER, EMERY, GREENE and others. Further written discussions on the subject in general are invited.

The Secretary announced the death of HENRY F. WALLING, M. Am. Soc. C. E., U. S. Geological Survey, Boston, Mass. He became a member in May 1868, and died April 8, 1888.

The Convention of 1888 will be held at Milwaukee, Wis., during the last week in June. Arrangements as to transportation are in progress with the Passenger Associations and Committees, whereby it is expected that a rate of one and one-third full fare will be made for the round trip from all points on the lines of the roads represented by such Associations.

New papers or discussions on papers already published are invited. A concise abstract of any paper to be presented, should be sent to the Secretary not later than May 31. This will make discussion more probable, as a copy of the abstract will be sent to members who may be expected to contribute discussions.

Engineers' Club of Philadelphia.—The regular meeting was held May 5: President JOSEPH M. WILSON in the chair and 34 members present.

The Secretary presented for Mr. OSCAR SANNE, an illustrated description of a Rolling Bridge for Docks. The author says: "During my stay with the Dominion Bridge Co., I was called upon to make a design for a rolling bridge. This structure was to be used at the Government Dock at Quebec. In regard to the form of the truss I would like to say that I consider it a very economical one and use it myself exclusively in draw-spans, wherever I have a chance. It also adds very favorably to the appearance of the structure. In comparing the design with another one for the same purpose where plate girders were used, I found a saving of weight in favor of my design of about 75,000 lbs.

"The estimated weights were found to be as follows:

	Lbs.
Trusses and connection	66,946
Machinery and shafting	2,940
" castings	12,019
" brass	394
Counterweight and I-beam support	69,500
Track	87,645
Total	239,444

"The bridge has to be moved back the full width of the channel, which is 69 ft. 5 ins. The machinery is designed to open it in 2 min. 54 sec. Before bridge is started the apron has to be lifted, thus helping considerably for counterbalance. The details of the machinery show worm gearing; this does not seem the most economical arrangement, but the little space which was given to fit the machinery into made this arrangement necessary. All shapes are of steel, eye-bars and rods of iron. This structure is to be built this spring, and I hope will prove a success."

Mr. ROBERT A. CUMMINGS presented, for the Reference Book, a Table of Equality of Curves at Different Scales, by means of which a set of curve patterns cut for a certain scale, can be used for other scales. Mr. M. R. MUCKLE, Jr., described a general and detail arrangement for a system of Underground Conduits for Electrical Conductors, with numerous illustrations. Mr. HENRY G. MORRIS presented a number of specimens of Mitis-Metal castings, and an illustrated description of the furnace used in their manufacture.

HOWARD MURPHY,
Secretary and Treasurer.

Western Society of Engineers.—The 247th meeting was held April 9, the President in the chair. The minutes of the last meeting were read and approved after the following change had been made:

The Memorial to Congress was reconsidered, and the first "Whereas" amended to read as follows:

"The system under which our National Public Works is conducted is subject to severe and just criticism, being without a well considered policy or a consistent purpose."

A communication was received from Mr. T. J. NICHOLL, Vice-President, and General Manager, Natchez, Jackson & Columbus Railroad, accompanied by a letter from the Pennsylvania Steel Co., advocating the use of rails 33½ ft. long, as standard, as cars are now 34 ft. After an informal discussion, the letters were ordered placed on file.

The following report was received from Committee on Highway Bridges.

The committee on highway bridges, in its report, read at the meeting of the Society on March 6, made the following recommendations:

"We think that improvement in the character of highway bridges can be brought about by the following means:

The Governor of each State to appoint an engineer, whose duty it shall be, to examine and report on existing bridges, with authority to condemn unsafe structures, and to act as expert adviser to the legislature on all questions and measures pertaining to the construction of new work.

Cities and counties should be encouraged to employ engineers who are bridge specialists to prepare specifications and complete detail plans for bridges, and tenders from contractors should be received on the basis of these specifications and plans. In order to facilitate the adoption of this method, we think it highly desirable that engineers agree upon a scale of minimum rates for doing such work on a similar plan to that in vogue among architects."

The committee was continued with instructions to report the best practical means for carrying these suggestions into effect.

We now beg to submit the following supplemental report;

Inasmuch as we think it desirable that any action taken shall be, as far as possible, the joint action of all organizations similar to our own, we recommend, as a step preliminary to such joint action, that the Secretary be instructed to place himself in communication with other local engineering societies, and request from them an expression of opinion on the subject under consideration.

Respectfully submitted,

C. L. STROBEL.
A. GOTTLIEB.
E. C. CARTER.

The report was discussed at length by Strobel, Williams, Cregier, Gottlieb, Bates, Parkhurst and others, and finally referred back to committee, with instructions to correspond with other societies, with a view to an expression of opinion and ultimate co-operation.

The question of permanent quarters, and generally of placing the Society upon a more substantial footing, was then taken up. The feasibility of accomplishing material results was generally conceded. The trustees were requested to consider the whole question and report a definite line of action.

The reading of papers was postponed until the next meeting.

Adjourned. L. E. COOLEY, *Secretary.*

Engineers' Club of Kansas City.—A regular meeting was held in the Club May 7. Present 14 members and 5 visitors.

The following were elected as Members; DANIEL BONTECOU, O. B. GUNN, E. I. FARNSWORTH, ALEXANDER POTTER, M. N. WELLS, WM. B. UPTON; as Associate Members: H. F. HILL, F. C. FLORENCE.

The Secretary read two communications from Mr. B. W. DE COURCY of Independence, Kan., describing some piers and abutments recently erected in Montgomery County, Kan., which had failed or were considered unsafe; also a bowstring girder in the same condition, stating that the county had lost considerable money in neglecting to procure professional advice. The Secretary presented for Mr. DE COURCY two photographs of the work, with specimens of the stone. The Secretary made a few remarks on the above masonry which he had been called upon to inspect, and presented results of tests of the stone made by Prof. J. B. JOHNSON of St. Louis.

Mr. DONNELLY being unable to present his paper on "Kansas City Pavements", Mr. MASON gave a brief description of those in use here, and especially of the Trinidad Asphalt Paving, a specimen of which from one of the Omaha streets, he presented to the Club. Mr. MASON believed that asphalt would eventually be the principal paving material used here on account of its durability, the ease with which it could be kept drained, and as it is found to be serviceable on grades as steep as 8 per cent.

KENNETH ALLEN, *Secretary.*

Montana Society of Civil Engineers.—An adjourned meeting was held April 28 at Helena, Mont.; Vice-President E. H. BECKLER in the chair, 12 members and 1 visitor present.

J. H. FARMER, late engineer in charge of the northern end of the Wickes tunnel on the line of the Montana Central Railroad, read a paper upon the location and construction of that tunnel, illustrating the same with a plan showing the various surveys made to determine the economic location of the tunnel, also with several sections and longitudinal sections showing the methods of construction. The paper proved a very interesting one to the members, who discussed its various features at some length.

The committee appointed to report on the action of the Society with regard to the proposed Reorganization of National Public Works reported as follows:

To the President and Members of the Montana Society of Civil Engineers.

GENTLEMEN:—

Your Committee appointed at the meeting of 21 inst., to suggest the proper action of this Society in connection with the movement looking to the "Reorganization of National Public Works", respectfully submit this their Report.

We have carefully read the pamphlets and other matters relative thereto—received from the "Executive Board of the Council of Engineering Societies on National Public Works", and believing the movement to be one that if successful will not alone redound to the advancement of the engineering profession but greatly to that of the country at large, we would state, that in our opinion the subject is one that should receive the hearty co-operation and support of this Society, and would therefore recommend the appointment of a permanent Committee on "National Public Works" and that they be authorized and instructed to promote the ends sought by the said "Executive Board", the same being fully set forth in the pamphlet issued by that Board entitled, "Reorganization of National Public Works, Art. 1, Proposed Legislation, Chicago, March, 1888."

Your Committee, therefore, suggests the discussion of the proposed Legislation and the adoption of the following resolution:

Memorial from the Montana Society of Civil Engineers to the Senate and House of Representatives of the United States of America in Congress assembled.

WHEREAS, The Legislation and Administration, affecting our National Public Works for years past, have not been such as to conduce to the accomplishment of the best work, but rather tend toward wasteful expenditures and with results not at all commensurate with the large amounts expended, and

WHEREAS, It is belived that a careful study of the whole question cannot but result in suggesting the framing of a definite policy and the establishment of a specific agency for its fulfillment, such as will tend toward placing our National Public Works upon that high plane of confidence with the public, to which its importance is justly entitled, and in developing a well defined system for which regular appropriation will be deemed a conceded requisite, and thus with the greatest possible economy develop those natural channels of commerce, upon which so largely depend the future progress and welfare of our country, therefore be it

Resolved, That the Montana Society of Civil Engineers approves the general purpose of the Cullom-Breckinridge Bill for the establishment of a Bureau of Harbors and Waterways, and believes that, in conjunction with proper changes in the Rules of Congress, it will remove the evils now complained of.

Resolved, That the modified bill, proposed by the Executive Board of the Council of Engineering Societies, has the endorsement of this Society subject to such revision in minor details as may upon its thorough study be deemed advisable.

Respectfully submitted,

J. S. KEERL,
GEO. O. FOSS,
JNO. W. WADE,
Committee.

HELENA, Mon. Ty., April 28, 1888.

Gen. B. H. GREENE, J. S. KEERL and W. A. HAVEN were elected a permanent Committee on National Public Works, and were authorized and instructed to promote the ends sought by the Executive Board of the Council of Engineering Societies on National Public Works.

The Secretary was instructed to send the Executive Board a contribution of $1 for each member of the Society toward the expenses incurred by that Board. The appointment of a manager to represent this Society in the Association of Engineering Societies was left to the Board of Trustees, who appointed J. S. KEERL for that position. The meeting adjourned to May 19.

Master Car-Builders' Association.—The Committee on Uniformity of the Interchangeable Parts of Cars has been appointed to consider the question, "How can uniformity in the interchangeable parts of cars be obtained"? and to make a report thereon at the next convention of the Association. They therefore request members to reply to the following inquiries and to make any suggestions which will assist the committee in reporting on the subject.

1. How can railroad companies secure uniformity to the Master Car-Builders' standard in the shape of tread and flange, and the diameters of wheels which they make or buy?

2. How can Master Car-Builders secure uniformity in the distance between the backs of flanges of their own wheels and those which pass over their lines?

3. Are the gauges recommended by the Master Car-Builders' Association for the maintenance of uniformity in wheels and axles, the best that can be devised? If not, what kind of gauges would you recommend?

4. How can journal bearings, journal boxes and pedestals be made interchangeable and kept so?

5. How can brake shoes be made interchangeable and kept so?

6. How can the screws of bolts and nuts be made interchangeable and kept so?

7. In your opinion is it desirable for the Master Car-Builders' Association to adopt uniform non-automatic draw gear, and if so, should the present standard height of draw-bar and dimensions of dead-blocks be adhered to?

8. In the adoption of the Master Car-Builders' standard type of Automatic coupler, what steps should be taken to secure uniformity and interchangeability in draw-gear of that kind?

9. Besides those already adopted by the Master Car-Builders' Association, what other parts of cars should be standardized by the Association?

As the time before the next meeting is short, members are requested to answer the above questions promptly.

SAM'L IRVIN,
HARVEY MIDDLETON,
JOHN HODGE,
Committee.

Replies should be sent to SAM'L IRVIN, M. C. B., Missouri Pacific Railway, St. Louis, Mo.

Up to the present time the Master Car-Builders' Association has adopted the following standards:

1. Wheel tread and flange. 2. Diameters of chill moulds. 3. Distance between the backs of wheel flanges. 4. Axle. 5. Journal bearing. 6. Journal box. 7. Pedestal. 8. Gauges for wheels and axles. 9. Gauge for guard rails. 10. Brake shoes. 11. Screw threads. 12. Height of draw-bars. 13. Attachments of draw-bars. 14. Dimensions of dead blocks. 15. Attachments for the safety of train men. 16. System of marking cars. 17. Type of automatic coupler.

CONSTRUCTION NEWS.

RAILROADS.

East of Chicago.

Existing Roads.

Raritan River.

JERSEY CITY, N. J., May 15, 1888.

EDITOR ENGINEERING NEWS:

The Raritan River Railroad is to run from South Amboy via Washington and New Brunswick to Bound Brook, a distance of 20 miles. Surveys are all finished, capital for building has been secured, and the contract has been let to John L. Butman of Saratoga, N. Y. The line to be completed by Dec. 1, 1888. Work has already commenced and track-laying will begin by June 1, and it is expected to have a portion of the line open for traffic by July 15. There are some heavy sand cuttings on the line and numerous iron bridges. The one across the Raritan will have three 100 ft. spans. The enterprise is an independent one and is not backed by any existing company. EDWARD H. RIPLEY is President of the Company.

E. W. HARRISON, Chief Engineer.

Rockaway Valley.—Ground was broken on May 15, on this New Jersey road, which is to run from White House on the Central Railroad of New Jersey to New Germantown, a distance of 4 miles. J. N. PIDCOCK is President of the company. The line is to be operated by the Central of New Jersey.

Zealand Valley.

ZEALAND, N. H., May 16, 1888.

EDITOR ENGINEERING NEWS:

This line was originally built as a logging road but it will be used for carrying passengers during the coming summer. The line is now 7 miles in length. No extensions are likely for 2 years. J. E. HENRY is President of the company.

J. H. HENRY, Treasurer.

Pemberton & Hightstown.—This line was abandoned by the Pennsylvania Railroad on May 1, but those injured by the stopping of business on the line have brought suit against the company and the matter of its legal right to close the line at its pleasure will be tested in the courts.

Boston, Concord & Montreal.—The suit for the appointment of a receiver for this line has been compromised, and transferred by agreement to the New Hampshire Supreme Court, by whose decision both parties agree to abide. The Boston & Maine company agrees to forthwith put the line into first class condition before the opening of the season for summer travel.

Rockland Limerock.—The contract for the construction of this line at Rockland, Me., has been let to Jas. Mitchell and Parker Spofford. The line will be about 7 miles in length, extending from the limestone quarries near the city to the kilns on the water front.

South Pennsylvania.—EDWARD C. KNIGHT of Philadelphia has been prominently mentioned as the President of the reorganized company. The $10,000,000 of bonds are reported to have been all taken. Among the prominent subscribers are D. O. MILLS, J. B. COLGATE and the ROCKEFELLERS. The backers of the enterprise claim that the suits of the Pennsylvania will not materially hinder the enterprise. Unless the whole movement is a scheme for unloading the stock of the company upon the public, it is certain that the completion of the South Pennsylvania will be undertaken at once.

Baltimore & Ohio.—The improved financial status of this company is evidenced by the fact that the new bond issue of $7,500,000 opened for subscription in London and New York at the same hour was all taken in London before the hour for opening had arrived in New York, owing to the difference of time between the two cities.

Cornwall & Lebanon.—President ROBERT H. COLEMAN has publicly announced his intention of building at once the line from Lebanon to Reading, and surveys are now in progress under Chief Engineer THOMAS R. CROWELL.

Rochester & Glenhaven.—Work is in progress on this short line at Rochester, N. Y. F. S. MINGES is President and WM. C. GRAY is Chief Engineer.

Delaware, Lackawanna & Western.—This company has purchased the graded road bed of the defunct Greenwood & Rexville railway, extending from Canisteo to Rexville, N. Y. It is reported also that the company will build a line from Rexville southwest 45 miles to Coudersport, Pa., to open up an extensive lumber tract.

Toledo, Columbus & Southern.—A 4 mile extension is to be built at Findlay, O.

New York, Mahoning & Western.—Tracklaying has begun on this line at Ottawa, O., and the short section graded between Ottawa and Findlay will be put in operation soon. R. D. Silsby of Findlay is the contractor for tracklaying.

Cleveland & Canton.—It is reported that a contract has been made with the Pittsburg, Marion & Chicago by which that company will have the use of the Cleveland & Canton tracks from Minerva, to Canton, 18 miles. From here the Pittsburg, Marion & Chicago will use the Coshocton branch of the Cleveland & Canton to reach Beach City, from which point the road will be constructed westward to Marion, O.

Grand Trunk.—Reports from Ottawa state that the company is applying for assistance from the Government in double tracking its line from Montreal to Toronto, and in constructing the St. Clair tunnel and the Ontario & Sault Ste. Marie extensions.

Cincinnati, Wabash & Michigan.—The extension of this line from Anderson to Bushville, Ind., will be undertaken this month.

Lackawanna & Pittsburg.—A party of surveyors are at work on the 40 mile extension to Geneva, N. Y.

New Projects and Surveys.

Haverhill & Lawrence.

HAVERHILL, Mass., May 15, 1888.

EDITOR ENGINEERING NEWS:

Our line is to run from Haverhill *via* Bradford and Methuen to Lawrence, a distance of 8 miles. Capital for construction has been secured by stock subscriptions and right of way is all secured except in Lawrence where it is now being secured. W. B. THORN, of Haverhill, Mass., is President.

C. E. WIGGINS, Director.

Sandusky, Ashland & Coshocton.—The city of Sandusky, O., has voted a $200,000 subsidy in aid of this enterprise.

Erie Southern.—This company is obtaining subscriptions at Erie, Pa. The project is for a line to connect the Nypano system with Erie.

SOUTHERN

Existing Roads.

Richmond & Danville.—It is reported that this company has bought the Atlantic & Danville and that the Danville & New River Narrow Gauge will be purchased at the sale on July 2. The former line will be completed to Danville and the latter will be pushed westward to Bristol, Tenn.

Atlanta & Florida.—This Georgia road has 70 miles of track down, and it is expected to reach Fort Valley in 60 days. To what point the line will be built from Fort Valley has not yet been decided.

Louisville, New Orleans & Texas.—A subsidy of $150,000 has been voted to this company by Bolivar County, Miss., for which the company agrees to build an extension of its Huntington branch through Bolivar county to a connection with the main line by Jan. 1, 1890. ——Surveys are in progress for the extension from Centreville to Woodville, Miss.

Louisville Southern.—The company has made a proposition to the city of Lexington, Ky., to build the branch which has been surveyed from Lawrenceburg to that city, about 25 miles, for a subsidy of $100,000. The last rail has been laid on the line between Louisville and Harrodsburgh.

Americus, Preston & Lumpkin.—It is reported that an extension will soon be undertaken from Louvale, Ga., westward to the Chattahoochee river, about 10 miles.

Carolina, Knoxville & Western.—A large force is a work on this line near Greenville, N. C., on the grading and some heavy trestle work.

Baltimore & Ohio.—Work has been suspended on the tunnels at Washington and Claysville on the Pittsburg & Wheeling division of the Baltimore & Ohio. There are seven tunnels on this line and all but the two on which work has stopped have been widened for a double track line.

Louisville, St. Louis & Texas.—The work on completing the grading and tracklaying of this line along the Ohio river from Louisville, Ky., west has been actively resumed.

Central R. R. of Georgia.—A press dispatch from Atlanta, Ga., May 16, says:

Gen. E. P. ALEXANDER, President of the Central Railroad system, contemplates forming a new company to be composed of the Columbus and Western, the Savannah and Columbus, the Buena Vista and Ellaville, the East Alabama, the Columbus and Rome, the road from Ozark to Eufaula, the new road from Americus to Savannah, and a new line from Americus to Eufaula. The Central owns these roads, and they will be united and known as one road. The name has not yet been determined upon, but it is likely to be called the United Railways. This system when complete will embody at least 800 miles of first class road. This new system will contain 337 miles of road already complete, and divided as follows: Columbus and Western, 160; East Alabama, 37; Columbus and Rome, 50; Buena Vista and Ellaville, 30; Eufaula and Ozark, 60.

The roads and extensions projected are as follows: From Americus to Savannah, 180 miles; branch from the Columbus and Western to Murphey's Valley, 40 miles; extension of the East Alabama Road, 30 miles; extension of the Columbus and Rome Road to Newnan, 25 miles; extension of the Eufaula and Ozark Road to some point in Southeast Alabama, 100 miles; branch to Dublin from some point on the new road from Americus to Savannah, 40 miles; extension of the Buena Vista Road to Columbus, 35 miles. This movement maps out an immense amount of work; yet Gen. ALEXANDER is confident that all of the projects will be carried out. One of the most important projects of the Central is the extension of the Columbus and Rome Road to Newnan. This is now a narrow gauge road, but will be made a broad gauge.

New Projects and Surveys.

South Bound.—A meeting of the incorporators of this South Carolina company was held at Augusta, Ga., on May 8. C. J. C. HUTSON, the Chairman, reported that $50,000 had been subscribed to the stock and it was voted that ten per cent. be paid in for the purpose of making surveys. The line is to run from Columbia, S. C., to Savannah, Ga., and it is proposed to make surveys of three routes. Among those interested are W. T. TYSON and JOHN L. HAMMOND of Savannah; L. W. YOUMANS and ALFRED ALDRICH of Barnwell, S. C. W. J. LAWTON, and J. C. RICHARDSON of Savannah. A meeting will be held at Savannah in June to elect officers.

Washington, Western & Southwestern.—This company held a meeting at Luray, Va., on May 10 and elected Gen. LAFAYETTE BINGHAM of Washington President and Jos. A. JEFFRIES of Warrenton, Va., Secretary. Committees were appointed to solicit stock subscriptions along the line.

Concord & Albemarle.—A preliminary survey has been made for a railway line from Concord to Albemarle, N. C., about 15 miles.

THE NORTHWEST.

Existing Roads.

Indianapolis, Decatur & Western.—The Indianapolis, Decatur & Springfield Company has been reorganized under the above title and the property was taken from the receiver's hands on May 11. President HAMMOND is reported to have said that the Chicago, Burlington & Quincy managers have agreed to build an extension from Quincy to Beardstown, Ill., provided the Indianapolis, Decatur & Western builds from Decatur to Beardstown.

Red River Valley.—According to dispatches from Winnipeg, tenders have been asked for completing this line, a loan of $1,500,000 having been secured by the Provincial Government of Manitoba.

Milwaukee, Lake Shore & Western.—A bill is before Congress granting this company right of way through the Flambeau Indian reservation.

St. Paul, Minneapolis & Manitoba.—Grading and tracklaying are in progress on the Willmar & Sioux Falls extension.

Illinois Central,—A dispatch from Chicago states that the warehouse and lightering station to be built by the company on its lands on the Chicago water front will cost about $2,000,000.

Chicago, St. Paul & Kansas City.—The Iowa Central Railroad Company has been incorporated by Messrs. A. B. STICKNEY and others to acquire the property of the Central Iowa railway and organize it as a part of the Chicago, St. Paul & Kansas City system.

Sioux City Rapid Transit.—It is reported that work has begun on this railway in Sioux City, Ia., the contract for the 3¼ miles of surface line having been let to Mark Naughton. There will be about 2½ miles of elevated structure. F. A. HILL, of Sioux City is Chief Engineer.

New Projects and Surveys.

Eau Claire, Mississippi & Lake Superior.—This company has been incorporated by residents of Eau Claire, Wis., to build a railroad from Winona, Minn., *via* Independence, Eau Claire and Chippewa Falls, to a point on Lake Superior, in Ashland county. R. F. WILSON, GEO. B. SHAW, WM. A. RUST, H. M. STOCKING, and others, are interested.

Sioux & Southwestern.—This company has been incorporated in Wisconsin to build a railroad from Alma, Wis., across the Mississippi river to a point in Wabash county, Minn., a distance of two miles.

Duluth & Dakota.—This company has been incorporated, in Minnesota, by WM. RHODES, JOHN A. CROWLEY, L. M. FISHER, and others, of St. Paul, to build a railroad from Duluth through northern Minnesota and Dakota.

Peoria Belt.—A meeting was held at Peoria, Ill., on May 10, to discuss the project for a belt railroad. A survey has been made; but the railroads now entering the city are not inclined to favor the project and it is doubtful whether anything will be done at present unless the Santa Fe, the Alton, or the Illinois Central can be induced to take an interest in the matter. The cost of the proposed line would be about $500,000. WASHINGTON CORRINGTON of Peoria is interested in the project.

St. Paul & Minneapolis Elevated.—There are now two companies seeking for a franchise from the City Council of St. Paul, for building an elevated railway between the cities of St. Paul and Minneapolis. The first company, the St. Paul and Minneapolis Rapid Transit, is headed by P. R. L. HARDENBERGH, C. W. HACKETT, J. P. MOORE and others. The ordinance granting them a franchise has been before the City Council for about 8 months, and it is now promised that action will be taken upon it at once. The other company, whose incorporation was noted last week, has also applied for a franchise, agreeing to give a $500,000 bond for the completion of the road in two years.

Duluth, Glencoe & Southwestern. This Minnesota company whose incorporation was noted in our issue of April 28, has voted a 10 per cent. assessment on the subscriptions to capital stock and authorized a preliminary survey are to be made at once. A. H. REED of Glencoe is President.

THE SOUTHWEST.

Existing Roads.

Galveston, Sabine & St. Louis.

LONGVIEW, TEX., May 12, 1888.

EDITOR ENGINEERING NEWS:

The Galveston, Sabine & St. Louis Railway, for the past two years in the hands of a receiver, was on Wednesday last, sold at public outcry under order of the Federal Court and was purchased by Chas. M. Whitney & Co. of New York City, the owners of the connecting line, and the two will hereafter be managed as one road under the name of the Texas, Sabine Valley & Northwestern Railway Company.

RICHARD J. EVANS, *General Manager.*

St. Louis & San Francisco.—At the annual meeting held at St. Louis, May 10, the old Board of Directors were re-elected. The annual report shows a mileage of 1,095 miles. The gross earnings were $6,222,344, an increase of $1,354,716. The operating expenses were $2,668,090, an increase of $610,066.——It is reported that a surveying party which has just begun work on a line from Monett, Mo., toward Kansas City, is in this company's employ.

San Antonio & Aransas Pass.—The extension which is under construction from Kennedy to a junction with the Texas Mexican railway, at Collins, has reached a point 12 miles from Collins, and will be finished by June 1. It is reported that a third rail will be laid on the Texas Mexican road from Collins to Laredo, so that the Aransas Pass trains may run to that point.

Atchison, Topeka & Santa Fé.—The annual report gives the following statement of the construction work in 1887: The expenditures during the year for real estate and the construction of new roads was $40,774,561.56, of which $3,561,725.17 was expended by the A., T. & S. F. in Chicago, $14,123,838.79 in the construction of the C., S. F. & C. Railway, $510,931.53 in the bridge at Ft. Madison, and $579,318.17 in the bridge at Sibley.

The mileage of the whole system now stands as follows:

Santa Fé	2,080·85
Southern Kansas	935·50
Sonora System	350·19
Owned jointly	113·78
Total	3,480·32

In addition to the above the Santa Fé company either owns entirely or controls the following mileage:

C., S. F. & C.	498·25
St. J. & St. L.	95·70
St. L., K. C. & C.	61 40
Chicago, Kansas & Western	903.16
G., C. & S. F.	1,022·16
California Southern	210·61
California Central	183·55
Total	2,974·83
Joint control of St. L. & S. F., and Atlantic & Pacific	918·86

If the mileage of the latter be omitted, it will be found that the mileage of the Atchison properties alone was 6,341.37 miles. The bonded indebtedness of this mileage, including the income bonds of the Chicago, Kansas & Western railroad company, was $120,798,000, being at the average rate of $19,049 per mile.

At the directors' meeting following the stockholders' meeting, it was decided that no new lines of importance should be put under construction at present.

Marshall, Paris & Northwestern.—D. R. SCOTT of Paris, Tex., has been elected President of this company to succeed JOHN MARTIN, resigned. An additional ten mile section of the road is to be built this season.

Missouri Pacific.—H. H. HARDING, General Manager of the Jefferson City & Southwestern extension from Bagnell, Mo., to Carthage is obtaining right of way along the line. Surveys were made last summer and it is thought the line will be built this season. The company agrees to have trains running on or before two years from the present date, in its application for the right of way.

The fight between JAY GOULD and the holders of the securities of the Missouri, Kansas & Texas has been compromised and the suits have been withdrawn. Mr. GOULD assumed that the opposing faction would be successful in electing its ticket for a new board of directors on May 16, and proposed to Messrs. BULL and MARTINSEN that a committee should be appointed by each side to consider all matters of dispute and arrange for the continuous harmonious operation of the Missouri Pacific and Missouri, Kansas & Texas.

Texas Western. This company's line, extending from Houston, Tex., to Sealey, 53, miles and for a long time in a Receiver's hands, has been ordered by the United States Court to suspend business on June 1 until further notice.

New Projects and Surveys.

Hot Springs & Western.—Incorporated in Arkansas to build a 15 mile railroad from Hot Springs to a point on the Ouachita river. A. B. GAINES and C. D. GREAVES of Hot Springs are interested.

Paris, Choctaw & Little Rock.—This company has been organized to extend the Memphis & Little Rock railroad from Hot Springs, Ark., to Paris, Tex. S. J. WRIGHT is President, D. H. SCOTT, is Vice-President, L. P. HARRISON is Treasurer.

Dallas & New Orleans.—This company has filed a mortgage to the Mercantile Trust Company of New York City for the sum of $4,500,000 on its proposed line from Dallas southeast toward New Orleans.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Northern Pacific.—Construction is to begin at once on the extension of the company's line along the water front at Tacoma, W. T.——A contract has been closed with a large lumber company for the construction of a 40 mile branch line into the timber regions of the Cascade Mountains, east of Tacoma. Most of the lumber is to be shipped to Eastern markets over the company's lines.

Oregon Pacific.—Three parties of engineers are at work on the cross-sectioning of the line, and it is hoped that funds may be forthcoming for resuming work on the grading at an early date.

Southern Pacific.—It is believed that the company will back the Pomona & Elsinore enterprise. The line has been located by Chief Engineer TREADWELL, and a favorable route has been found with maximum grades of 70 ft. per mile. Grading has made considerable progress between Pomona and South Riverside. ——A contract has been let to NELSON BENNETT for the construction of a branch 18 miles long from Orting, W. T., to Carbonado. There will be two short tunnels on the line. The Huron Branch is being extended west to coal mines.

By the annual report the mileage of the whole system is given at 5,576 miles. The gross earnings were $37,930,000; operating expenses, $22,712,000; net earnings, $15,218 000. The net surplus over fixed charges is $1,035,000.

Denver & Rio Grande.—The schemes for extension which are to be pushed at the annual meeting on May 22, are the lines from Glenwood Springs down Grand River Valley, the Salt Lake City extension, the Lake City branch, and the New Mexico extension from Espanola to Albuquerque. A delegation of Albuquerque business men will urge the early construction of the last named line.

Seattle, Lake Shore & Eastern.—It is stated that contracts for the completion of the entire line from Seattle to Spokane Falls are to be let at once. Contracts are to be let at once for a 40 mile division of the Seattle & West Coast Railroad. PAUL MOHR of Seattle is Chief Engineer.

Tehuantepec.—The London *Financial News* illustrates the route of the proposed railway across the Isthmus of Tehuantepec for the construction of which a concession has been granted by the Mexican Government to a London syndicate headed by Colonel MCMURDO, the builder of the Delagoa Bay railroad in South Africa. There has been already constructed 29 miles of the road on the Atlantic end and 38 on the Pacific, leaving 140½ miles to be built to complete the line. The portions of the line already built are the most difficult and cost £8,100 per mile. As is well known, the Tehuantepec route saves 1,131 miles between Liverpool and San Francisco over the Panama route. The portion of the line to be built will pass through a rich mining district in the Mexican highlands. It would seem certain that the construction of this line must have a favorable influence on the Eads Ship Railway enterprise by turning the current of commerce over this route and bringing its advantages into prominence.

Portland & Vancouver.—This company calls for bids for constructing about 7,000 ft. of trestling across the Columbia river bottom at Portland, Ore. The company's headquarters are at Portland.

New Projects and Surveys.

Port Townsend & Southern.—This Washington Territory company is obtaining aid at Port Townsend, W. T., agreeing to build 20 miles of its road by July 1, 1890, and 25 miles per year thereafter until the line reaches the Columbia river.

Spokane Falls & Northern.—The following officers have been elected: President A. A. NEWBERRY, Vice-President, W. H. TAYLOR, Secretary, T. E. JEFFERSON Treasurer, JAS. N. GLOVER, Chief Engineer, FRANK E. HABERSHAM.

Oroville & Beckworth.—This company has been chartered in California to build a railway from Oroville, Butte county, through the Feather river valley to Beckworth, Plumas county, about 100 miles. The incorporators are J. E. DOOLITTLE, W. D. WOODBURY, N. W. GRISWOLD, C. M. OAKLEY and O. G. SHEATH. The principal office is to be San Francisco.

Contracting.

Grading.—The contract for grading for the side tracks and switches of the Portland & Willamette Valley Railway at the works of the Oregon Iron & Steel Co. at Oswego, has been let to Bays & Joffery. There will be 2.8 miles of grading, and the cost will be about $15,000. The work will begin at Trian Creek bridge. About 60,000 yards of grading is to be done and the work will be pushed as it is to be completed by the time the iron works commence operations, which will be about July 1.

A New Pavement.—J. M. HAZEN, formerly Assistant Building Inspector, has got hold of what he thinks is going to prove a popular pavement. It is known as the Telford macadam pavement, and is being adopted at Chicago. The cost is less than the asphalt, about $1 more per sq. yd. than cedar block, and will last longer than any other. This pavement is composed of a stone foundation, each block 8 ins. thick, 12 ins. wide and 15 ins. long, laid in parallel lines across the street, and with broken joints. On this is placed an intermediate layer of broken stone, from 1 to 3 ins. thick, and 4 ins. in depth at the center of the street. The surface layer is composed of stone cubes, which will pass through a 2-in. ring, covered with screened gravel or sand, thoroughly rolled. The necessary material for this pavement can be found in Minneapolis, and it is believed it will prove an improvement on cedar block pavement. —St. Paul (Minn.) *Pioneer Press.*

Laying Water Pipe, Etc.—The following proposals for laying pipe for pump main No. 5 have been received by HENRY FLAD, President, Board of Public Improvement, St. Louis, Mo.: D. Clifford & Co., laying 36-in., 12-in. and 6-in. pipe, $1.75, 50 cts. and 30 cts. per lin. ft.; setting fire plug, $8; wrought-iron straps, bands and bolts, 8 cts. per lb.; total, $4,366. Fruin-Bambrick Construction Co., $1.97, 45 and 25 cts., $8, 7 cts., $4,874. Patrick O'Donnell, $2.44, 34 cts. and 20 cts., $8, 8 cts., $6,009.60. John J. Brown $2.88, 40 and 20 cts., $8, 7 cts., $7,053. The contract was awarded to D. Clifford & Co.

Artesian Well.—At Toledo, O., the following proposals were received April 30 for boring an artesian well W. O. Einsberger, $1,90 per ft. in earth and rock; T. T. Munger, $2.80 per ft. in rock and $1 in earth; Frank Hake $3 in rock and $1,25 in earth. The contract was awarded to W. O. Einsberger.

Beacon St. Sewer.—Proposals have been received by ASPINWALL & LINCOLN, Civil Engineers, of Boston, for sewer work on Beacon St., in Brookline, Mass. Section 1: James Killian, $3,414.56; Metropolitan Construction Co., $3,901.65; Collins & Ham, $5,179·13; Charles Linehan, $6,016.95; Whittaker & Wright, $7,176; Stephen Connelly, $8,360.71; John I. Dorey, $8,461.31; A. W. Bryne, $8,479.03. The 8, 12 and 15-in. pipe were furnished to the contractor, and the piles furnished and driven for him, leaving only the cement, sand and labor to bid on.—— Section 3; James Killian, $16,837.46; Metropolitan Construction Co., $18,048.79; Dennis O'Connell, $19,126.14; Collins & Ham, $20,409.15; Neil McBride, $20,984.70; John Coleman, $21,938.22; Charles Linehan, $21,939.62; Solomon Sanborn, $23,258.08; A. W. Bryne, $24,779.65; Stephen Connell, $25,068.71; John I. Dorey, $25,863.75; Whittaker & Wright, $29,001.77. The bids for rock excavation ranged from $1.95 to $5.75 per cu. yd. The work includes brick sewers, 36-in., 24 x 36, 30, 20 x 30, all 4-in. work; also 8, 10, 12, 15 and 18-in. pipe, with manholes.——The remaining work was for catch basins and small pieces of sewer work; it was let to James Killian at $5,268.07. The other contracts were also let to Mr. Killian.

Heating Apparatus.—The Board of Education, Atlanta, Ga., has awarded the contract for heating and ventilating apparatus for the new grammar school to I. D. Smead & Co., of Toledo, O.——The Board of Education, Connersville, Ind., has awarded the contract for heating and ventilating apparatus and dry closets to I. D. Smead & Co.

Levee.—The contract for building the levee in the Hunt drainage district below Warsaw, Ill., has been awarded to James Summers for $59,000, to be paid in bonds running 20 years at 6 per cent. Bonds taken at 85 per cent. of face value. Work will commence as soon as as the river falls. A corps of Government engineers has been ordered to Alexandria, Mo., to repair and strengthen the dike.

The Capital at Albany, N. Y.—Mr. I. G. PERRY, the Capital Commissioner, has submitted plans and estimates for necessary work for which a bill appropriating $350,000 has been introduced. The totals are as follows:

Completing the shoring up and centreing and removing the present stone ceiling of the Assembly Chamber, constructing a new ceiling, and doing necessary work in connection therewith, including the strengthening of the walls at either end of the Assembly Chamber	$233,265 01
Reconstructing the golden corridor	35,293 50
Repairing stone dressings in the present library room	2,186 25
Rebuilding the Assembly staircase	63,800 00
Total	$334,544 76

New Croton Aqueduct.—At the meeting of the Aqueduct Commissioners, New York City, on April 25, a form of release was adopted, as presented by the Committee on Construction, to be executed by John Brunton & Co., Ridger, Shanly & Co., and the American Surety Co., releasing 200 ft of tunnel excavation south of Shaft 30, and also of said shaft from their contracts, and stipulating that the Commissioners may advertise for doing the work at that point.

The following proposals for furnishing, delivering, and laying 48-in. cast-iron pipes and their appurtenances, from 135th St. and Convent Ave. to the proposed gate-house in the Central Park reservoir, and doing all other work in connection therewith necessary to complete Section 16 of the New Aqueduct, were opened May 9 by the Commissioners:

QUANTITIES.	O'Brien & Clark.	Mathew Baird.	Wm. E. Dean.	Miles Tierney.	W. S. Colem'n & Co.	Engineer's Estim'te
120,000 cu. yds. earth excavation	$ 36,000	$ 30,000	$ 30,000	$ 84,000	$ 30,000	$ 36,000
60,000 cu. yds. rock excavation	87,000	90,000	100,500	90 000	165,000	120,000
160,000 cu. yds. refilling and embankment	40,000	48,000	24,000	16,000	32,000	56,000
1,500 cu. yds. brick masonry	15,000	18,000	22,500	18,000	18 000	18,000
1,200 cu. yds. concrete masonry, 5 to 1	6,000	6,000	5,400	6,000	6,000	6,000
900 cu. yds. concrete masonry, 3 to 1	1,800	1,800	1,425	1,800	1,800	1,800
500 cu. yds. rubble-stone masonry	3,000	2,500	1,750	2,000	2,500	2,500
1,000 cu. yds. dry rubble-stone masonry	3,000	3,000	2,500	3,000	4,000	4,000
50 cu. yds. dimension-stone masonry	2,500	1,250	1,850	2,000	3,250	2,500
25,000 sq. yds. Telford-McAdam pavement, taken up and relaid	25 000	31,250	30,000	25,000	37,500	31,250
4,000 sq. yds. block pavement taken up and relaid	2,000	2,400	2,400	2,000	5,000	6,000
6,000 sq. yds. stone block pavement, taken up and relaid	3,600	3,600	3,600	3,000	7,500	7,500
24,700 tons cast-iron straight pipe	617,500	623,675	666 900	617,500	623,675	741,000
800 tons special castings	43,200	44,680	48,000	43,200	41,600	48,000
5 tons wrought-iron work	500	500	475	750	500	500
4 48-in. stop-cocks	6,000	8,800	10,800	8,000	8 000	8,000
14 12-in. stop-cocks	1 400	630	658	1,400	5,600	700
8 6-in. stop-cocks	400	200	168	400	800	200
12 blow offs	600	240	180	600	1,200	180
5 hydrants	350	350	350	250	500	350
Laying 70,000 lin. ft. 48-in. cast-iron pipe	119,000	105,000	77,000	126,000	140,000	175,000
Laying 500 lin. ft. 20-in. cast-iron pipe	375	360	225	500	500	625
Laying 2,000 lin. ft. 12-in. cast-iron pipe	800	1.000	600	1,000	1,500	1,200
Laying 500 lin. ft. 6-in. cast-iron pipe	200	150	150	125	250	175
200 lin. ft. 6 in. stoneware sewer pipe	100	50	200	100	120	60
300 lin. ft. 10-in. stoneware sewer pipe	210	180	375	210	240	180
800 lin. ft. 12 in. stoneware sewer pipe	500	300	1,000	400	700	350
1,500 lin. ft. 15-in. stoneware sewer pipe	2,550	1,200	3,750	1,500	1,875	1,875
360,000 ft. B. M. hemlock timber	7,200	8,640	7,920	7,200	10,800	10,800
Total	$1,030,215	$1,040,475	$1,053,232	$1,069,545	$1,155,295	$1,280,765

The contract has been awarded to O'Brien & Clark.

Dam.—The following proposals for building an embankment dam 370 ft. long and 15 ft. high above foundations, near Whitinsville, Mass., have been received by A. C. MOORE, C. E., Southbridge, Mass. The contract was awarded May 10, to T. P. Kinsley.

	Surfacing.	Excavat'n.	Embankment.	Loam on Slopes.	Lumber M.	Road Filling.	Total.
T. P. Kinsley, Syracuse, N. Y.	cts .08	cts. .22	cts. .23	cts. .08	$ 26	cts. .21	$1,860.00
Thomas Hennessey, Holden, Mass.	.10	.38	.38	.10	30	.35	2,846.60
G. W. Hendrick, Easthampton, Mass.			50.			.30	2,880.00
J. R. Rooke, Framingham, Mass.	.15	.24	.21	.15	35	.29	3.020.00
M. O'Connor & Co., Boston, Mass.	.20	.28	.42	.20	32	.45	3,180.00
J. E. Brooks, N. Y. City.	.25	.30	.35	.25	35		3,310.00
Leach & Baldwin, Woodbury, N. J.	.17	.23	..42	.16	33	.24	3.405.00
S. C. Newell, Uxbridge, Mass.						.25	3,775.00
A. A. Harrigan, Abington, Mass.	.15	.25	.40	.15	62.50		3,776 50
E. C. Munson, Allston, Mass.							4.125.00

Track Material.—The following proposals have been received by JAMES FULTON, Paymaster General, U.S.N., Navy Department, Washington, D. C.: *Steel rails*, 156 tons of 50 lbs. per yd.; Rowland A. Robbins, New York, $34.97 per ton; Jas. Symington, New York, $35.50; Thompson C. Gill & Co., Philadelphia, Pa., $36.45; C. W. & H. W. Middleton, Philadelphia, $38.25; J. W. Gaskill & Sons, Philadelphia, $39. Contract awaded to Rowland A. Robbins.—*Steel angle plates*, 1500: R. A. Robbins, 2.97 cts. per lb.; Jas. Symington, 2¾ cts.; J. W. Gaskill & Sons, 3 cts.; Thompson C. Gill & Co., $2 per 1000. Contract awarded to T. C. Gill & Co., Philadelphia.—*Track bolts*, 3,200, with Harvey's lock nuts; Jas. Symington, 3¼ cts. per lb.; J. W. Gaskill & Sons, 3⅛ cts.; R. A. Robbins, 3.74 cts.; T. C. Gill & Co., 4.3 cts. Contract awarded to Jas. Symington, New York.—*Draw spikes*, 10,500: Jas. Symington, $2.25 per 1000; J. W. Gaskill & Sons, $2.50; T. C. Gill & Co., 2.3 cts. per lb.; Tredegar Co., Richmond, Va., 2.3 cts.; R. A. Robbins, 2.47 cts. Contract awarded to Jas. Symington.—*Switches*, 5 split steel: J. W. Gaskill & Sons, $33 each; C. W. & H. W. Middleton, $34; R. A. Robbins $35.40; T. C. Gill & Co., $37; Jas. Symington, $39.50. Contract awarded to J. W. Gaskill & Sons.—*Frogs*, 5 steel: J. W. Gaskill & Sons, $20 and $23 each for No. 6 and No. 8; C. W. & H. W. Middleton, $23, $25; T. C. Gill & Co., $24, $26; Jas. Symington & Co., $25, $29; R. A. Robbins, $22 for No. 8. Contract awarded to J. W. Gaskill & Sons.—*Switch stands*, 5 ground lever: R. A. Robbins, $4.20 each; J. W. Gaskill & Sons, $4.60; Jas. Symington, $3.95; C. W. & H. W. Middleton, $5; T. C. Gill & Co., $7. Contract awarded to R. A. Robbins.—*Cross ties*, 5,700 creosoted yellow pine ties; S. D. Puller, Norfolk, Va., $4,464; Trant & Bro., Portsmouth, Va., $4,503; J. W. Gaskill & Sons, $5,013; C. W. & H. W. Middleton, $5,347.60; Creosote Lumber & Construction Co., Fernandina, Fla., $5.415; Frank S. Wyckoff, Williamsport, Pa.; $6,599; Carolina Oil & Creosote Co., Wilmington, N. C., $4,372.19. Contract awarded to S. D. Puller.—*Railroad tools*; James W. Soper, New York, $186.74; R. A. Robbins, New York, $195.26; J. W. Gaskill and Sons, $256; T. C. Gill & Co., $40 for rail benders only. Contract awarded to J. W. Soper.

Steel Arch Bridge.—The following proposals have been received by the Commissioner and Town Board for a bridge over the Salmon river at Pulaski, N. Y.: Berlin Iron Bridge Co., East Berlin, Conn., $8,884, $9,600, $6,900, $6,100. Dean & Westbrook, New York, $9,300, $9,000, $10,900, $10,100. Groton Iron Bridge Co., Groton, N. Y., $9,000, $8,800, $8,700, $8,500. King Iron Bridge & Mfg. Co., Cleveland, O., $8,981, $7,562, $7,188. Pittsburg, Bridge Co., Pittsburg, Pa., $9,000. Penn Bridge Co., Beaver Falls, Pa., $11,485. Smith Bridge Co., Toledo, O., $8,450, $10,950, $8,250, $10,825, $9,000. Wrought Iron Bridge Co., Canton, O., $8,500, $8,835. M. White, $7,500 (informal). General plans and specifications were prepared by J. H. EHREHART, City Engineer of Utica, N. Y., and called for a deck bridge 335 ft. long, with one roadway 16 ft. wide, and two sidewalks 5 ft. clear width each. The contract was awarded to the Wrought Iron Bridge Co., of Canton, O., on its plan for a steel arch of 216 ft. span with iron trestle approaches. Contract price, $8,835.

Reservoir.—The City Water Board of Wheeling, W. Va., has rejected all the bids for the construction of the new reservoir, and will call for new bids in a few days. H. P. WILKINSON, Secretary.

Sewerage.—The city of Gadsden, Ala., will establish a system of sewerage and the work will be done by contract. Maps, plans and specifications will be ready in a short time. Bonds will be issued by the city to the amount of about $50,000. For particulars apply to JOHN H. DISQUE, Mayor, Gadsden, Ala.

Foundry Work.—Hackettstown, N. J., May 15. Workmen in this vicinity are exuberant over the tidings that the Warren Foundries, owned by Cooper & Hewitt, will be put in blast this week, employing several hundred hands. These works have been idle during the last 5 years, owing to the depressed condition of the iron trade, during which time the business interests of the town have been paralyzed. Working men are already pouring into the town and an era of prosperity is expected.

Stand-Pipes.—E. Hodge & Co., of East Boston, Mass., have been awarded contracts for stand-pipes at Everett, Mass., and Boothbay, Me. That at Everett will be 22 ft. diameter by 36 ft. high, and that at Boothbay will be 30 ft. diameter and 45 ft. high.

Water-Works.—*Fort Riley, Kan.*—The following proposals have been received by Capt. GEORGE E. POND' Asst. Q. M., U. S. A., for the system of water-works: Jno. Dwyer & G. W. Pearsons, Kansas City, Mo., 8 wells and connections complete, $2,059 and $3,400; boiler house, pump pit and reservoir, $11,148; machinery, $8,543; pipe system, hydrants and valves, $22,978; extension or diminution of pipe system, $1.19, 82 cts. and 57 cts. per ft. for 8, 6 and 4-in.; for entire system complete of 44,8726 for plan No. 1 of wells and Gaskill pumps, $43,969 for plan 1A and Gaskill pump, $43,428 for plan 1 and Deane pump, $44,669 for plan 1A and Deane pump Heaton & Cook, Junction City, Kan., $44,450 for works complete, Deane pump. F. A. Smith, New York, $34,900 for works complete, Blake pump. National Water Supply Co., Cincinnati, O., wells, plan 1, $4,000, galvanized iron; plan 1 A, $3,600, black pipe, $3,000, not guaranteed. Deane Steam Pump Co., Holyoke, Mass., machinery, $9,145. Jas. A. Medaris, Junction City, Kan., wells, $1,750 and $2,350. Ziegler & Dalton, Junction City, Kan., boiler house, pump pit and reservoir, $11,576. W. H. STAIR, C. E., is Superintendent of Construction.

Bridges.—*Fort Worth, Tex.*—The following proposals for the construction of the Trinity river bridge and iron trestle approach have been received by the City Engineer. Length of bridge and approach, 640 ft.; 24 ft. roadway, two 5 ft. sidewalks. Columbia Bridge Co., Dayton, O., $19,900; King Iron Bridge & Mfg. Co., Cleveland, O., $20,200, $21,200; Missouri Valley Bridge Co., Leavenworth, Kan., $22,880; Kansas City Bridge Co., Kansas City, Mo., $23,156; Wrought Iron Bridge Co., Canton, O., $24,350; Penn Bridge Co., Beaver Falls, Pa., $24,375; Smith Bridge Co., Toledo, O., $24,500, $25,500; Variety Bridge Works, Cleveland, O., $25,540; Phœnix Bridge Co., Phœnixville, Pa., $27,500; Milwaukee Bridge Co., Milwaukee, Wis., $27,300, $26,745, $26,000; N. Ostrom, Dallas, Tex., $29,700. The contract was awarded to the Smith Bridge Co., at $24,500.

Lincoln, Neb.—The King Iron Bridge & Mfg. Co., of Cleveland, O., has the contract for two combination bridges for the county commissioners.

Oregon City, Ore.—The County Commissioners, of Clackamas Co., have awarded the contract for a suspension bridge across the Willamette river, at Oregon City, to the Pacific Bridge Co., of San Francisco, Cal., for $23,000. The bridge will be 935 ft. long, 450 ft. main span, 75 ft. above low water. It is to be completed by September 1.

Oakley, La.—The Bridge Committee have awarded the contract for the Deer creek bridge to the King Iron Bridge & Mfg. Co., of Cleveland, O., for $2,750.

Street Work.—*Providence, R. I.*—Contracts have been let as follows: Paving Prairie Ave.; Walter S. Seamans, of North Providence; taking up and removing present pavement, 20 cts. per sq. yd.; furnishing and laying 18-in. cross walk stone, 62 cts. per sq. ft.; furnishing and laying granite blocks, $2.37 per sq. yd.; earth excavation and filling, 50 cts. per cu. yd.—Paving South Main St.; Thos. Newman, of Brooklyn, N. Y.; taking up and removing present cobble pavement, 10 cts. per sq. yd.; furnishing and laying 18-in. crosswalk stone, $1.05 per sq. ft.; furnishing and laying granite blocks, $3.20 per sq. yd.; earth excavation and filling, 60 cts. per cu. yd. S. M. GRAY, City Engineer.

Brooklyn, N. Y.—The following proposals for flagging sidewalks have been received by JOHN P. ADAMS, Commissioner of City Works: John Morrissey, 21¾ cts. per sq. ft.; Charles S. Lyman 21 cts.

Albany, N. Y.—The following proposals for cobble pavement on Bradford St. have been received by the Board of Contract and Apportionment; THOS. J. LANAHAN, Clerk: P. H. Reilly, cobble, $1.40 per sq. yd.; sidewalk, $1.42 per sq. ft.; curb, 66 cts. per lin. ft.; crosswalks, 29 cts. per sq. ft. Jacob Holler, $1 43, $1 45, 65 cts., 30 cts. A. N. Brady, $1 40, $1 60, 67 cts, 25 cts. The contract was awarded to P. H. Reilly.

Newark, N. J.—Contracts have been awarded as follows by ERNEST ADAM, City Surveyor: Central Ave. and Orange St.; John F. Shanley: oblong granite paving, $2.70 per sq. yd.; Belgian bridging, 30 cts. per sq. ft.—Bergen St. James Conway & Terence McManus: excavation, 37½ cts. per cu. yd.; 20-in. curb, 45 cts. per lin. ft.; bridging, 33 cts. per sq. ft.

Baltimore, Md.—The following proposals have been received for work on Wilkens Ave.: Owen Patterson: grading, 30 cts. per cu. yd.; paving, 65¢ cts. per ft.; resetting crib, 10 cts.; repaving, 35¢ cts. Pinning Bros., 10, 5, 2½ and 6 cts. Jas. P. McGovern, 10, 7, 1 and 1 cts.

Wheeling, W. Va.—The following proposals for brick paving have been received: A. Yates: of Charleston, $1.48 per sq. yd., Charleston plan: John H. Daniels and J. L. Stout, $1.25 for Charleston plan and $1.10 for Wheeling plan, 30 cts. per cu. yd. for excavation; N. W. Tucker, $1.30 Charleston plan, $1.26 Wheeling plan, $1.69 Wheeling plan, with fire brick: F. E. King & Co., $1.32 per sq. yd. Charleston plan, 40 cts. per cu. yd. for excavation. The Council has decided to accept the Charleston plan of using planks under the brick.

Toledo, O.—The City Council has awarded contracts as follows: Paving Bridge St.: Claflin Paving Co. and John B. Miller: grading, 22 cts.; stone and wood curb, 60 and 20 cts.; gutter stone, 50 cts.; crosswalk stone, 61 cts.; iron, 3 cts.; abutments, 50; paving, $2.15; catch basins, $35; manholes, $25; brick, $20.

Terre Haute, Ind.—Proposals for street work have been received by GEO. B. GRIMES, City Engineer, ranging from $1.35 per lin. ft. for 53 ft. wide to $1.60 for 65 ft. wide

Stone Culvert.—The following proposals for a stone culvert, with wings, have been received by Capt. GEO. E. POND, Asst. Q. M., U. S. A., Fort Riley, Kan.: Jas. Tully Junction City, Kan., $1,775; Dalton Bros., Junction City, Kan., $2,000; John Oberg, Junction City, Kan., $2,240; Huese & Moses, Clay Centre, Kan., $2,450; J. K. Wright, of Junction City, and Jas. Houston, of Wamego, Kan., $2,948; J. Dwyer & G. W. Pearsons, Kansas City, Mo., $3,366; Larkworthy & Menke, Quincy, Ill., $3,405; Engstrom & Johnson, Junction City, Kan., $4,365. The culvert will be 200 ft. long, 9 ft. span, 6 ft. nigh. W. H. STAIR, C. E., is Superintendent of Construction.

Granite Blocks.—Col. J. H. DRAKE, proprietor of the Monarch Jasper granite quarries at Sioux Falls, Dak., has contracted to supply 700 car loads of granite paving blocks to Kansas City, Mo., and 500 car loads to Nebraska, City, Neb.

Sewer Prices.—The following contract prices for sewers are from the report for 1887 of City Engineer ALBERT B. HILL, New Haven Conn.: 72-in. brick sewer on pile foundation, $26.60 per ft.; 72-in. brick on grillage foundation, $22.10; 36-in. brick on pile foundation, $10.80; 36-in. brick, $6.52; 30 and 24-in. brick with 8-in. invert, $5 and $3.56; 12, 15 and 18-in. vitrified pipe, $1.32, $1.73 and $1.98.

Dredge and Supplies.—The following proposals for furnishing 1 dredge, 1 tug and 2 dump scows for removing shoals at the Harbor of Refuge, Sand Beach, Lake Huron; also for supplies for the same work, have been received by Lt. Col. O. M. POE, U. S. Engineer Office, Detroit, Mich.: For dredge, etc., Hickler & Green, Sault Ste. Marie, Mich., $9.23 per hour; C. F. Dunbar, Buffalo, N. Y., $12; Carkin, Stickney & Cram, East Saginaw, Mich., $12. Timber and plank, Henry Howard & Co., Port Huron, Mich., $2,821.84; Carkin, Stickney & Cram, $2,835.12. Coal, Geo. W. Jenks, Sand Beach, Mich., $375. Ship chandlery, H. D. Edwards & Co., Detroit, $222.66. Hardware, T. B. Rayl & Co., Detroit, $194.99; Hodgson & Howard, Detroit, $196.66; J. Jenks & Co., Sand Beach, Mich., $205.48. Hoisting scows, Frontier Iron & Brass Works, Detroit, $264; Wm. H. Wain, Detroit, $276.

Water-Works. — ***Goderich, Ont.***—The following contracts have been awarded: for 535 tons of cast-iron pipe and special castings, Alex. Gartshore, $35 per ton for 4, 6, 8 and 10-in. pipe, $60 per ton for castings, total $18,994.63; excavating and pipe laying, 35,000 ft., Harding & Leathorn, 16½, 19½, 23½, and 29½ cts. for 4, 6, 8 and 10-in. pipe, $6,756.30. Two boilers, 14 ft. x 62 ins., Chrystal & Black, $2,580, including feed pump. Bids for hydrants, valves and valve boxes ranged from $1,760.60 (duty to be added) to $2,743. The bids for pumping engines were held over.

Proposals Open.

Masonry and Brick.—Laying 1,400 yds. of first-class rubble masonry; also laying 2,000,000 brick; stone and brick furnished on the ground. Engineer, FRANZ CAZIN, M. E., Pioneer Building, Denver. EDMUND B. KIRBY, Superintendent, Denver Smelting & Refining Co., Denver, Col.

Dam.—Water-works dam; estimated cost, $10,000. THE BOARD OF VILLAGE TRUSTEES, Staunton, Ill.

Telephone Supplies.—Wire, cedar poles, insulators, etc., etc. S. I. KIMBALL, General Superintendent, U. S. Life Saving Service, Washington, D. C. May 19.

Bridge Work.—Raising bridge and abutments; also lumber for bridge. H. W. BANNISTER, City Clerk, Syracuse, N. Y. May 21.

Boilers.—Three boilers. A. B. RICHARDSON, Secretary, Trustees of the Asylum, Athens, O. May 22.

Lumber.—For the Water Department. LOUIS LESAGE, Superintendent of Water-Works, Montreal, Canada. May 22.

Public House.—Custom house, etc., at Richmond, Va. Stone, brick and iron work, roof covering, all interior finish, plumbing and gas piping. WILL. A. FRERET, Supervising Architect, Treasury Department, Washington, D. C. May 23.

Sewers.—In District No. 3. Plans and specifications on file. CHARLES DE MOISEY, City Engineer, Fort Scott, Kan. May 23.

Masonry.—Two abutments and one pier at Downingsville, Grant Co., Ky.; from 500 to 800 cu. yds. of stone. Bids per cubic yard. Plans and specifications at the office of the County Clerk, Williamstown. NICHOLAS WEBSTER, Williamstown, Grant Co., Ky. May 25.

Pier Work.—Removing part of pier, old 36, at the foot of N. Moore St., North River, and removing shed thereon; also building new pier and shed. THE DOCKS COMMISSIONERS. Pier A, North River, New York City. May 28.

Street Work.—Taking up and relaying pavment on various streets. THE COMMISSIONER of PUBLIC WORKS, 31 Chambers St., New York City. May 28.

Dredging.—At pier, new 43, and at pier at the foot W. 55th St., North River. THE DOCKS COMMISSIONERS, Pier A, North River, New York City. May 31.

Public Building.—Post office at Prescott, Ont. A. GOBEIL, Secretary, Department of Public Works, Ottawa, Ont., Canada. May 31.

Court House.—At Ouray, Col. Two bids, one for entire building, the other for main building without the wing. Architects, F. E. EDBROOKE & Co., Tabor Block, Denver Col. T. H. MOORE, County Clerk and Recorder, Ouray, Col. June 1.

Granite.—Cut granite, about 9,500 cu. ft., for the basement front walls of the Congressional Library building. EDWARD CLARK, Architect of the Capitol, 145 E. Capitol St., Washington, D. C. June 2.

Penitentiary—Plans and specifications for Territorial Penitenthary at Rawlins, Wyo. Cost of building complete, iron-work, cells, sewerage, closets, steam heating apparatus, stockade walls, etc., not to exceed $100,000. The sum of $250 will be paid for the accepted plans. JAS. P. WALLACE, Secretary of the Territorial Penitentiary Building Commission, Rawlins, Wyo. June 5.

Railway.—From Winona to Columbus, Miss. THE CHIEF ENGINEER, Georgia Pacific Ry., Birmingham, Ala. May 28.

WATER.

A Fire Hydrant Invention.—The Baltimore *Sun* describes an invention patented by HUGH L. MCAVOY, of Baltimore, and S. HAMILTON CAUGHY. "The invention consists of a supply pipe leading underground or otherwise from a harbor, river or lake; the source end is submerged and is provided with a check valve which prevents the water from flowing back. The hydrant end is an upright pipe with a fire plug at the surface of the ground; it is fitted with an air chamber and with a waste valve which empties the upright pipe when not in use. There are no taps or valves and the fire engines can couple up to the plug and draw a supply of water at once."

Jersey City, N. J.—With regard to the advertisement for proposals for a water supply, to be opened May 7, Mr. M. FINCK, Clerk of the Board of Public Works, writes as follows: "The Board is not yet organized. Bids should have been received on May 7. Advertisements discontinued. Nothing further will be done in the matter of water supply until ordered by the Board."

Land and Water Companies.—The following companies have been organized in California:

Fullerton Land & Water Co. Stock, $1,000,000. H. G. Wilshire, Wm. B. Wilshire, C. B. Carpenter, E. B Amerige, G. H. Amerige.

Junipa Land & Water Co., Los Angeles. Stock, $3,000,000. F. C. Howes, G. A. Fridickar, F. Mohr, E. A. Mesarre, S. C. Ward.

San Jacinto Land & Water Co. Stock, $75,000. Jos. A. Cook, Auburn, N. Y.; Chas. L. Cooper, L. F. Olmsted, T. A. Jobs, J. McLaren, San Jacinto.

Fairmount Land & Water Co., Los Angeles. Stock, $200,000. Wm. L. Clapp, F. J. Curlin, W. H. Crosby, E. G. Durent, E. M. Durent.

High Mesa Land & Water, Los Angeles. Stock, $240,000. A. Glassell, Geo. H. Smith, Geo. S. Patton, A. J. Hutchinson, T. R. Brown.

Coatesville, Pa.—The large supply pipe of the reservoir was disjointed or broken May 10, and all the water ran out. This was the second time within a few weeks that the water supply had been cut off by the breaking of the pipes.

Gas Companies Consolidate.—At Baltimore, Md., the Consolidated, Equitable and Chesapeake gas companies, have been consolidated under the name of the name of the New Consolidated Gas Co., of Baltimore City. Capital stock, $11 000,000.

Malden, Mass.—At a recent Council meeting, the committee on additional water supply made its report, which showed that the wells in Eaton's meadow had been tested 84 days at an expense of $8,800, and the average amount pumped daily was 846,000 galls. The report of State Assayer Downs showed the water to be pure and in every way fit for domestic purposes, and the engineer recommended the use of these wells as an additional supply for the city. The committee recommended the acceptance of the report and the appointment of a committee to secure an additional supply from Eaton's meadows. Councilman PIERCE asked the Council to accept an act of the Legislature in relation to providing the city with an additional supply. He was satisfied that the wells in Eaton's meadow could be relied upon to yield 1,000,000 and probably 2,000,000 galls. per day. Councilman Cox was opposed to the acceptance of the act, and said it would be a waste of money to further experiment with the wells in Eaton's meadow, as it was sure to prove a failure in the end.

Water-Works.—***Maine.***—Brewer. A new water company has been formed to control the water supply. President, F. M. LAUGHTON, Bangor; Treasurer, F. H. CLEBOUE, Bangor; Clerk, F. A. FLOYD.——Fryeburg. The Fryeburg Water Co. is in a prosperous condition, the stock being worth $120 per share. President, L. C. SHIRLEY; Secretary, Dr. D. L. LAWSON; Superintendent, A. R. JENNESS.

Vermont.—Burlington. Contracts will soon be let for the construction of the new reservoir; capacity 3,000,000 galls.

Connecticut.—Mystic. It is reported that the water-works will now be put in at once; the work has been very much delayed.

New York.—Haverstraw. The West Haverstraw Water Co. has been incorporated. President, JOHN LOCKWOOD, New York; Secretary and Treasurer, JOHN C. LOCKWOOD. Capital stock, $1,000. The supply will be by gravity.——Jamaica. The Jamaica Township Water Co. has been incorporated. President, JOHN LOCKWOOD; Secretary and Treasurer, JOHN C. LOCKWOOD. Capital stock, $10,000. Operations will be carried on at Hollis Morris Park, Richmond Hill, Woodhaven, and Ozone Park; pipes to be extended to Brooklyn line. The Jamaica Water Supply Co. will extend its system by 2 miles of pipe; extra hydrant rental, $500.——Hempstead. The Averne Water Co. has been incorporated by R. VERNAM and C. E. HOFFMAN, of Hempstead; EMERSON W. PERRY, of New York; THOS. QUINN, of Brooklyn, and JAMES R. BOYD, of Metuchen, N. J. Capital stock, $60,000.——Coeymans. The village will try to have water for fire purposes from the pipes of the West Shore R. R.——Honeoye Falls. A well for the water-works is being sunk by Burton & Crone.——Seneca Falls. The new stand-pipe, 80 ft. by 30 ft., has been completed.

New Jersey.—Long Branch. The water company is putting in 12 filters. Water is supplied to Long Branch, Monmouth Beach and Seabright.——Orange. The Water Committee will make improvements at the reservoir.

Pennsylvania.—Etna. As no satisfactory terms for a water supply could be made with the Sharpsburg authorities, a system of water-works will be put in by G. A. CHALFANT. There will be a stand-pipe. The population is about 4,000.——Irwin. Water-works will soon be contracted for.——Greensburg. Surveys have been made for the new 5,000,000 galls. reservoir. Pipes may be laid to Grapeville and Irwin.——Uniontown. Work has been commenced on the pipe line and the third reservoir of the Uniontown Water Co. The large increase in the population of the town makes the building of an additional 3,000,000 galls. reservoir necessary to furnish enough water. When completed the three reservoirs will have a capacity of 20,500,000 galls.

Ohio.—Sidney. The city will spend about $60,000 in improving the water-works, according to the plans of GEO. HORNUNG, C. E. A stand-pipe will be erected.

Virginia.—Portsmouth. The water-works were put in operation May 5, and the city was supplied with water from Lake Kilby, near Suffolk.——Manchester. Mr. White, of New York, who will build the water-works, has purchased pipe and will commence work soon.——Roanoke. HOWARD MURPHY, engineer of the water-works, has put men at work clearing away the debris in the south basin of the reservoir, in order to make investigations before beginning the repairs of the basin.

Kentucky.—Lebanon. Water-works are projected; and bonds for $60,000 proposed to be issued to build them.

Georgia.—Carrollton. Water-works are contemplated. Address the City Clerk.

Alabama.—Birmingham. The Birmingham Water-Works Co. will build an aqueduct to bring water from Five Mile creek; a site for a reservoir has been selected and a tunnel will be driven through Red Mountain. The work will cost about $500,000.

Illinois.—Lewistown. Work is progressing on the pipe laying for the new water-works.

Minnesota.—Winona. The City Engineer has been directed to prepare plans and specifications for the improvement of the water-works.——St. Peter. On May 8 the proposition to issue $32,000 in bonds for water-works was carried by a majority of 257.

Wisconsin.—Sheboygan. The water company will extend its system by 4¼ miles of pipe, and will set 45 additional hydrants.

Missouri.—Washington. The Water Committee has received 3 proposals from Eastern firms. A vote on the water question will be taken June 1.

Kansas.—Leavenworth. A new Worthington pump has been ordered by the Leavenworth Water Co. It will have a daily capacity of 6,000,000 galls., and cost $30,000.——Leoti. The water-works are to be completed by July 1.

Arkansas.—Lonoke. Water-works are contemplated For particulars address the Mayor.

Oregon.—Pendleton. The reservoir of the city water-works will soon be completed.

California.—Los Angeles. The Los Angeles Water Co. has increased its capital stock from $413,000 to $1,240,000.——Sonoma. The Sonoma Valley Water Co. I said to have struck a flow of 280,000 galls. per day by tunneling into Terrace hill.

Texas.—La Grange. Water-works will be built by th La Grange Water-Works Co.——Fort Worth. There i talk of selling the city water-works to a private company.

Joliet, Ill.—The litigation between the city and the water company, which has been in progress for several years, has been settled by arbitration. The board of arbitrators decided that the city must pay the company $186,620 for the works. This does not please either side, the city claiming that the works are only worth $130,000, while the company claims that the works are worth double the amount named.

What Cheer, Ia.—The city council has perfected arrangements for putting down an artesian well to the depth of 1,200 ft. The contract has been given to Barnard, the foundry man, at $2,550, and bonds to the amount of $4,000 will be issued, to pay for the work and also to purchase machinery for pumping, and put in mains to conduct the water along the main streets.

Clyde, N. Y.—Bassett Bros., of Buffalo, have the contract for water-works. There will be 40 hydrants, and the village will pay $1,600 per annum for 5 years for water for fire purposes.

A Water Company Taxed.—At Selin's Grove, Pa., the collector of school tax of the borough, has levied upon the supplies in the office of the Selin's Grove Water Works Co. and will sell them at public sale May 26, for the payment of tax. The water company claimed to be exempt from all borough and school tax, and consequently refused to pay.

Jackson, Miss.—Several proposals for the construction of water-works were opened by the City Council on May 11, and the contract was awarded to the Light, Heat & Water Co., of Jackson. The company agrees to lay 8 miles of mains and to furnish 80 miles of fire hydrants, to be placed at points designated by the city, and supply water for $4,800 per annum. It also agrees that private parties shall not be charged more for water supply than is charged by any other of water-works company in the State. The work is to be commenced in 60 days and will be completed in a year. The company is composed of Dr. P. W. PEEPLES, C. W. ROBINSON, R. L. SAUNDERS, S. S. CARTER, Dr. BYRON LEMLY, T. STRAUSS, C. A. LYERLY, R. W. MILLSAPS, S. S. CALHOUN and M. GREEN.

Water-Works Construction in Japan.—The description of the water-works of Jamaica and Patchogue, L. I.,—of which JOHN LOCKWOOD, 72 Broadway, is the designing and constructing engineer—published in ENGINEERING NEWS January 28, of this year, has so favorably impressed Engineer G. YAMASAKI, who is designing water-works for the town of Yokosuka, Japan, that he writes under date of April 6, for "a report and blue prints if there are any" of these works. He says "they would be invaluable aids to my present design and future execution". Engineer YAMASAKI, however, shows his American training by inadvertently overlooking any reference to compensation to Mr. LOCKWOOD for his "invaluable aid."

St. Paul, Minn.—For some time there has been a triangular dispute at St. Paul, between the city government, the business men and owners of property, and the underwriters, upon the efficiency for fire protection of the city water-works, the result of which has been, the declaration by the underwriters that the works, especially the street mains, are insufficient for proper fire protection in the business district, and the insurance rates have been advanced in many cases and the risks cancelled in others. By joint action of the City Council, Board of Trade and Chamber of Commerce, JOHN W. HILL, Mechanical Engineer, Cincinnati, has been selected to investigate and report upon the matter.

Artesian Wells in Texas.—A large number of artesian wells have been bored and tanks made in Western Texas during the last year, and the work is still progressing.

Special Reports of Water-Works Construction.

THE ENGINEERING NEWS MANUAL OF AMERICAN WATER-WORKS is now being compiled, and will be *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and will be of great value to Water-Works superintendents and projectors of new works.

Superintendents of water-works and water companies will wish to see correct and complete data concerning their Works in our MANUAL, and to ensure this they should send in reports *at once* upon the blanks which we have already sent to every Water-Works office in the United States and Canada. Many have delayed their report, and if the blanks we intended for them have been lost in the mail, or mislaid, we will send more upon request.

We *must* have a report from every public water supply system in North America, so those who reply to our inquiries at once will save a second inquiry. We also wish to know of *every* new Water-Works plant in process of construction, and of *every* new project in this line. We will send to any one desiring them, blanks upon which reports can be made.

Further details of the MANUAL will be advertised later. We abstract from our special reports for the MANUAL the following items of current interest.

BROCKVILLE, Ont., May 9, 1888.

EDITOR ENGINEERING NEWS:—Work will probably be begun July 1 and finished Dec. 1 on a system of water-works for Goderich, Ont. The works will be built by the city at a cost of $55,000, and the money has been voted for this purpose by the village. The village is on a level plateau, 150 ft. above Lake Huron and has a population of 4,000. Artesian wells will be driven at the lake level and the water forced by direct pumping to the village above for fire protection.

WILLIS CHIPMAN, *Engineer-in-Charge.*

BIRMINGHAM, Ala., May 12, 1888.

EDITOR ENGINEERING NEWS:—The Birmingham Water-Works Co. has had a corps of engineers in the field some weeks making surveys for an additional supply of water from Cahaba river, a rapidly flowing mountain stream running about 7 miles to the eastward of the city. Two mountain ranges are to be crossed and an elevation of 400 ft. to be overcome from the river to the top of the first mountain, on which will be constructed a reservoir of about 100,000,000 galls. capacity. The other mountain will be tunnelled for a distance of about 2,300 ft. About 30,000 ft. of 30-in. and 8,300 ft. of 24-in. pipe will be used.

BIRMINGHAM WATER-WORKS CO.

BOSTON, Mass., May 10, 1888.

EDITOR ENGINEERING NEWS:—Yours of May 9, at hand. We have filled out, and herewith enclose, report regarding the water-works we are now about completing at Janesville, Wis. Further, regarding Janesville, we would say that the city being well and closely built and in a bad way for water, we anticipate an unusually large number of consumers for the population. We would further state that the 13 miles of pipe to cover the ordinance does not more than half pipe the town, and we expect in the course of two or three years to have made such extensions as will render this one of the best works in the West. As the limited space in your blank does not permit the insertion of the particulars of the supply, we would say that the artesian well is cased down about 600 ft., thoroughly sealing out the water from the upper stratum of limestone, and taking its entire yield from the underlying stratum of Potsdam sandstone, the well flowing with a head of 28 ft. above the surface of the ground. The storage reservoir being located near the well, receives and stores the discharge from the same excepting when the pumps are running, when the yield of the well is taken direct into the pumps, being reinforced by the water stored in the reservoir, the stand-pipe being located at the opposite end of the pipe system from the pumping station. The pipe system ranges from 16 to 6 ins. in diameter, being very carefully planned and almost entirely free from dead-ends. TURNER, CLARKE & RAWSON.

The following is the detailed description of the above named works as given by Messrs. Turner, Clarke & Rawson:—The population of Janesville is 12,000. B. R. CLARKE was Designing, and J. FRANK WILLIAMS, Constructing Engineer. F. F. CROFT is Superintendent. The works are owned by the Janesville Water Co., of which B. R. CLARKE is President, A. B. TURNER, Treasurer, and J. E. DODGE, Secretary. The company has capital stock and bonds to the amount of $200,000. The franchise is for 20 years, with a rental of $4,200 for the first 180 hydrants and $25 each for extensions. The hydrants are placed 400 ft. apart. The work was begun in June, 1887, and will be finished this month. The Wisconsin Construction Co., of Boston, Mass., had the contract for masonry, foundations and buildings. The other contractors were: For pumping machinery, Geo. F. Blake Mfg. Co., Boston. For pipe, Addystone Pipe & Steel Co., Cincinnati, O., and Donaldson Iron Co., Emaus, Pa. For specials, Builders' Iron Foundry, Providence, R. I. For trenching and pipe laying, Carroll E. Gray, Jr., Chicago, Ill. For hydrants, Coffin Valve Co., Boston. For gates, Rensselaer Mfg. Co., Troy, N. Y. For stand-pipe, Tippett & Wood, Phillipsburg, N. J.

The supply is from an artesian well 10 ins. in diameter cased to 8 ins., and 1,043 ft. deep. The water flows into a storage reservoir of 800,000 galls. capacity from which it is pumped to a stand-pipe 25 ft. in diameter by 85 ft. high, and having a head of 185 ft. There are three horizontal, tubular boilers of 80 H. P. each, and two duplex, compound, condensing engines, each of 2,000,000 galls. capacity. The mains are of cast-iron, and 13 miles have been laid. The services are now being put in, and are of galvanized iron. There are 180 hydrants, at present. The ordinary pressure in the mains is from 40 to 75 lbs. according to the different levels, and the fire pressure 125 lbs.

Annual Reports.

Norfolk, Va.—The annual reports of the municipal departments, with the Mayor's message, have just been issued in pamphlet form, but as they are for the year ending June 30, 1887, they are too far out of date for much comment. The city engineer calls attention to the bad condition of the streets which is owing to the paving being laid on wet mud or shifting sand instead of on a proper foundation, and the paving itself is of cobblestones and boulders, which are not suitable. For pumping the sewage a centrifugal pump was put in and proved more satisfactory than the piston pump. A report of Capt. THOS. W. SYMONS on the filtration of the water supply of Washington, D. C., is given in full. The total amount of water pumped was 380,550,589 galls. City Engineer, W. T. BROOKE; Superintendent of Water Works, H. L. SMITH.

Adams, Mass.—The Prudential Committee of the South Adams fire district have presented their report for the year ending March 10, 1888. The supply of water has been abundant and it has not been necessary to use the pumping station during the year. The water is of good quality. About 4,000 ft. of mains were laid, and 2,500 ft. of 4 in. mains, with 6 or 8 hydrants, are to be laid this season. Water is supplied to 1,593 families.

New Haven, Conn.—The Department of Public Works has issued its report for 1887. There are 20 bridges over streams, of which 8 are iron and the rest cheap wooden structures; within the city limits are 29 bridges over railroads, of which 9 are of iron, 1 stone and the balance of wood. The cost of maintenance of the roadways of the bridges has ranged from an average of 2.3 cts. per sq. ft. for 12 years for a swing bridge with iron floor beams and stringers, Burnetized spruce pavement and tar concrete top dressing, to 10.2 cts. per sq. ft. for 16 years for a wooden bridge with 3-in. Southern pine planking. During the year 3.97 miles of sewers were built, 24 to 74-in. brick and 12, 15 and 18-in. vitrified pipe; also 56 catch basins and 1 receiving basin built. There are now 49.557 miles of sewers, 842 new style and 89 old style catch basins, and 351 receiving basins. With regard to asphalt paving it is stated that the asphalt block pavement would be improved if the blocks were laid on a concrete foundation, but that would make it more expensive than sheet asphalt or concrete. The city has about 136 miles of streets, and less than one-fifth are paved. The grooved rail for street car lines is recommended. The report contains tables of work done and prices of bids for contract work. ALBERT B. HILL is City Engineer.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated.)

(CONTINUED FROM PAGE 394).

Ayer, Mass.—The works were commenced Aug. 10, 1887, and are now completed. The engineer was P. M. BLAKE, of Hyde Park, Mass. The contractors were as follows: for pumping machinery, Davidson Steam Pump Co., New York; for pipe and specials, R. D. Wood & Co., Philadelphia, Pa.; for valves and hydrants, Ludlow Valve Mfg. Co., Troy, N. Y.; for trenching and pipe laying, C. W. Talcott, Woonsocket, R. I.; for reservoir, J. R. Rooke, Framingham, Mass. The supply is drawn from a collecting well and pumped by a power pump of 450,000 galls. daily capacity to a reservoir with a capacity of 1,000,000 galls. There are 4¾ miles of cast-iron mains, 39 hydrants, 57 taps and 2 meters; the service pipes are of enameled iron. Ordinary pressure, 65 lbs. The works cost $56,000; debt, $56,000; rate of interest, 4 per cent. The works are owned by the town. Superintendent, H. W. WHITNEY. Present population, 2,500.

Carson City, Mich.—The works were commenced in January, 1888, and completed in April. They were designed by the Michigan Pipe Co., of Bay City, Mich., which had the contract for construction. The supply is drawn from Fish creek, a branch of the Maple river, and is pumped to a tank with a capacity of 1,600 barrels; direct pressure can be used for fire purposes. There are 3,000 ft. of wood pipe and 20 hydrants. The works cost $8,000; and bonds for this amount have been issued by the village, which owns the works; rate of interest, 6 per cent. Superintendent, A. L. HOLMES, of Grand Haven, Mich. Present population, 1200.

Raleigh, N. C.—The water-works were completed Oct. 1, 1887. The engineer was M. M. MOORE, 112 Liberty St., New York City. The contract for the works was taken by the National Water-Works Construction Co., Dayton, O.; the other contractors were, for pumping machinery, Smith & Vaile Co., Dayton, O.; for pipe, specials, Eddy valves and Matthews hydrants, R. D. Wood & Co., Philadelphia, Pa.; for tank, R. N. Mitchell and P. Linehan & Co., Raleigh, N. C. The supply is drawn from Walnut creek, 1¾ miles from the city, and pumped to a tank; direct pressure is available for fire purposes. There are two 40 H. P. boilers, 2 turbines and 4 pumps of 1,000,000 galls. daily capacity each. The tank is 30 ft. high by 23 ft. diameter and is carried on masonry 90 ft. high. There are 15 miles of mains, 120 hydrants, 187 taps and 14 meters; the mains are of cast-iron and service pipes of lead. Average daily consumption, 112,000 galls. Ordinary pressure 50 lbs.; fire pressure 50 to 90 lbs. Annual expense, $14,000, including interest on bonds. Annual revenue from city, $4,480. The works are owned by the Raleigh Water Co.; President, JULIUS LEWIS; Treasurer, W. W. SMITH; Superintendent, E. B. ENGELHARD; capital stock, $100,000. The franchise is for 20 years; annual rental, $37.50 per hydrant. Present population, 15,000.

(TO BE CONTINUED).